

SEQUENCE LISTING

SEQ ID NO: 1 amino acid sequence comprising GAS 40

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSQOKAELTELATALTKTTAEINHLKEQQDNEQKALTSAQBIYTNTLASSEETLLAQGAEHQRELTATE
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFVDPDNLTPFVQNELAQFAAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLI
RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFSSTNV
GSLNEHFVMFPESNIAHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQLOQKLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQT
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSS
LEATIATTEHQLTLKTLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSEMVASNAIVSKITSSITQPSSKTSYSGSGSSTTSNLI SDVDESTQRALK
AGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 2 polynucleotide sequence encoding for GAS 40

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCCAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAA
AAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACACTACTGCTGAAAT
CAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACTGCATTGTCAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAG
CTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAA
CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGA
TCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATC
GCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACG
TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGAATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCA
GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAACAAG
CACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTTGCAATATCT
AAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATT
TGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAA
GCAGGAGTCGTATGTTGGCAGCTGTGCGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 3 amino acid sequence comprising an N terminal leader sequence of GAS 40

MDLEQTKPNQVKQKIALTSTIALLSA

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SEQ ID NO: 4 polynucleotide sequence encoding an N terminal leader sequence of GAS 40

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCC

SEQ ID NO: 5 amino acid sequence comprising a fragment of GAS 40 with N terminal leader
sequence removed

SVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVEKTLSQQKAELTELATALTKTTAEINH
LKEQQDNEQKALTSAQEIYTNLTASSEETLLAQGAHQRELATETELHNAQADQHSKETALSEQKASISA
ETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEE
LAAQKAALAEKEAELSRLKSSAPSTQDSIVGNNTMKAPQGYPLEELKKLEASGYIGSASYNYYKEHADQI
IAKASPGNQLNQYQDIPADRNRFVDPDNLTPVQNELAQFAAHMINSVRRQLGLPPVTVTAGSQEFARLLS
TSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLIRNDDNMYENIGAFNDVHTVNGIKRGI
YDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFTSNVGSLSNEHFVMFPESNIAHQRFNKTP
KAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMAAQAKVSQSQGLASTLKQSDSLNLQV
RQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRD
FKLNP NRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSSLEATITTEHQLTLLKTLANEKEYRH
LDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLLEASARLAAENTSLVAEALVGQTSEMV
ASNAIVSKITSSITQPSSKTSYSGSSSTTSNLI SDVDESTQRALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 6 polynucleotide sequence encoding a fragment of GAS 40 with N terminal leader
sequence removed

AGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCA
CGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAATC
TCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAACTACTGCTGAAATCAACCAC
TTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGC
AAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGC
TTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTTCAGCA
GAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAATGC
TATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCT
CAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAAGAG
TTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCCGTC
TACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTAAAA
AATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATT
ATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCAGCAGATCGTAATCGCTTTGT
TGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATAGTG
TAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTTAGT
ACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATATTTGTCTACGGACAGCCAGGGGTATCAGGGCA
TTATGGTGTGGGCCCTCATGATAAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAAATG
ATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGTATT
TATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAACCT
TTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGATCTT
TGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCTATA
AAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGATCAA
AGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTTCATCAAGAAGCTGATATTATGGCAGCCCAAG
CTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAAGTG
AGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACAAC
CGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAGCCT
TAGCAGAGCAAGCCGACAGGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTGCAATATCTAAGGGAC
TTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTTGATAATACTAAGCAAGATTTGGCTAA
AACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAGAAG
CTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGCCAC
TTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCTATC
ATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACTATTAGAAGCTT
CAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATGGTA
GCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGGCTC

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AGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAAGCAGGAG
TCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 7 amino acid sequence comprising a C terminal transmembrane region of GAS 40
ALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 8 polynucleotide sequence encoding a C terminal transmembrane region of GAS 40
GCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAA
GTGA

SEQ ID NO: 9 amino acid sequence comprising a fragment of GAS 40 with a C terminal
transmembrane sequence removed

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSSQKAELELATALTKTTAEINHLKEQDNEQKALTSAQEIYTNLASSEETLLAQGAHQRELTATE
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFDVDPDLNLTPEVQNELAQFAHMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYQPGVSGHYGVGPHDKTIIEDSAGASGLI
RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAPVYLGFTSNV
GSLNEHFVMFPESNIANHQRFNKTPIKAVGSTKDYAQRVGTVDITIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQQLQGKLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQT
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNAQEALALQAKQSS
LEATIATTEHQLTLLKTLANEKEYRHLDEDIATVPDLQVAPPLTGKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSEMVASNAIVSKITSSITQPSSKTSYSGSGSSTTSNLI SDVDESTQR

SEQ ID NO: 10 polynucleotide sequence encoding a fragment of GAS 40 with a C terminal
transmembrane sequence removed

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
GAGTGCCAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAA
AAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAAT
CAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTGTCAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAG
CTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAA
CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGA
TCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATC
GCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACG
TGGTATTTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCGAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCA
GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAG
CACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTGCAATATCT
AAGGGACTTTAAATTGAATCCTAACCAGCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATT

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TGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGT
CTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACTATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAAGA

SEQ ID NO: 11 amino acid sequence comprising a transmembrane region of GAS 40 as shown in Figures 1 and 2. ALKAGVMLAAVGLTG

SEQ ID NO: 12 amino acid sequence comprising a first coiled-coil region of GAS 40
ETIQEAKATIDAVEKTLSSQKAELELATALTKTTAEINHLKEQQDNEQKALTSAQEIYTNLSSSEETLL
AQGAHQRELTAETELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDA
ITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAELSRLKSSA

SEQ ID NO: 13 amino acid sequence comprising a second coiled-coil region of GAS 40
RLSAIHQEADIMAAQAKVSQLOGKLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSL
AKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNA
QEALALQAKQSSLEATIATTEHQLTLLKTLANEKE

SEQ ID NO: 14 amino acid sequence comprising a leucine zipper motif within the second coiled-coil region of GAS 40.
QVIRERIDNTKQDLAKTTSSLLNAQEALAL

SEQ ID NO: 15 amino acid sequence comprising SpA from *Streptococcus gordonii* Genbank reference GI 25990270
MNKRKEVFGFRKSKVAKTLCGAVLGAALIAIADQQVLADEVTETNSTANVAVTTTGNPATNLPEAQGEATE
AASQSQAQAGSKEGALPVEVSADDLNQAVTDAKAAGVNVVQDQTSKGTATTAAENAQKQAEIKSDYAKQA
EEIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAKLAQYQKDL
AAVQKANEDSQLDYQNKLSAYQAEELARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQRNETAKANY
DAAMKQYEADLAAIKKAKEDNDADYQAKLAAYQAEELARVQKANADAKAAYEKAVEENTAKNTAIQAENEA
KQRNAAKATYEAALKQYEADLAAKKANEDSDADYQAKLAAYQTELARVQKANADAKAAYEKAVEDNKKAK
NAALQAENEEIKQRNAAKTDYEAALAKYEAADLAKYKKELAEYPAKLKAYEDEQAQIKAALVELEKNKNQD
GYLSKPSAQSLVYDSEPNAQLSLTTNGKMLKASAVDEAFSHDTAQYSKKILQPDNLNVSYLQQADDVTSSM
ELYGNFQDKAGWTTTVGNNTTEVKFASVLLERGQSVTATYTNLEKSYNGKKISKAVFKYSLDSDSKFKNVD
KAWLGVLDPDTLGVFASAYTGQEEKDTSIFIKNEFTFYDENDQPINFDNALLSVASLNRENNSIEMAKDYS
GTFVKISGSSVGEKDGKIYATETLNFQKQGQGSRWMTMYKNSQPGSGWDSSDAPNSWYGAGAI MSGPTNHV
TVGAISATQVVPSPVMAVATGKRPNIWYSLNGKIRAVNVPKITKEKPTPPVAPTEPQAPTYEVEKPLEPA
PVAPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVVPTYENEPTPPVKTPDQPEPSKPEEPTYET
EKPLEPAPVAPTYENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPVAPTPKQLPTPPVVPTVHFHYSSLLAQ
PQINKEIKNEDGVDIDRTLVAKQSIKFKELKTEALTAGRPKTTSFVLVDPLPTGYKFDLDATKAASTGFDT
TYDEASHTVTFKATDETLATYNADLTTPVETLHPTVVGRVLNDGATYINNFTLTVNDAYGIKSNVVRVTP
GKPNPDNPNNNYIKPTKVNKNKEGLNIDGKEVLGASTNYEELTWDLQYKGDKSSKEAIQNGFYVDDYP
EEALDVRPDLVKVADEKGNQVSGVSVQQYDSLEAAPKKVQDLLKKANITVKGAFQLFSADNPEEFYKQYVS
TGTSLVITDPMTVKSEFGKTGGKYENKAYQIDFGNGYATEVVVNNVPKITPKKDVTVSLDPTSENLDGQTV
QLYQTFNYRLIGGFIPQNHSEELDYSFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGTDLTSQTTA
ETDAANGIVTVRSKEDSLQKISLDSFPQAETYLQMRRIAIGTFENTYVNTVNVKAYASNTVVRTTTPIPRTP
DKPTPIPTPKPKDPKPKETPKPKVPSPKVEDPSAPIPVSVGKELTTLPKTGTNDSSYMPYLGLAALVGV
GLGQLKRKEDESN

SEQ ID NO: 16 amino acid sequence comprising Streptococcal surface protein B precursor from *Streptococcus gordonii* Genbank reference GI 25055226 AAC44102.3

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MQKREVFGRKSKVAKTLCGAVLGAALIAIADQQVLADEVTETNSTANVAVTTTGNPATNLPEAQGBATEA
 ASQSQAQAGSKDGALPVEVSADDLNKAVTDAKAAGVNVVQDQTSKGTATTAAENAQKQAEIKSDYAKQAE
 EIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAKLAQYQKDLA
 AVQKANEDSQLDYQNKLSAYQAELARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQRNETAKANYD
 AAMKQYEADLAAIKKAKEDNDADYQAKLAAYQAELARVQKANADAKAAAYEKAVEENTAKNTAIQAENEAIK
 QRNETAKATYEAAYKQYEADLAAVQKANATNEADYQAKLAAYQTELARVQKANADAKATYEKAVEDNKAKN
 AALQAENEEIKQRNAAAKTDYEAKLAKYEADLAKYKKDFAAYTAALAEAESKKKQDGYLSEPRSQSLNFKS
 EPNAIRTIDSSVHQYGOQELDALVKSWSGISPTNPDRKKSTAYSIFYNAINSNNTYAKLVLEKDKPVDVITYTG
 LKNSSFNGKKISKVVITYTLKETGFDDGKMTMFASSDPTVTAWYNDYFTSTNINVVKVIFYDEEGQLMNL
 GGLVNFSSLNRGNGSGAIDKDAIESVRNFRNGRYIPISGSSIKIHENNSAYADSSNAEKSRGARWDTSEWDT
 TSSPNNWYGAIUGEITQSEISFNMASSSKSGNIWFANSNINAIGVPTKPVAPTAPTQPMYETEKPLEPAPV
 VPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVAPTYPENEPTPPVKIPDQPEPSKPEEPTYETEK
 PLEPAPVAPTYPENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPLAPTQKQKLPVPTVHFHYSSLLAQPO
 INKEIKNEDGVDIDRTLVAKQSIGKFKELKTEALTAGRPKTTSFVLVDPLPTGYKFDLDATKAASTGFDTTY
 DEASHTVTFKATDETLATYNADLTTPVETLHPTVVGRLVNDGATYTNNFTLTVNDAYGIKSNVVRVTTPGK
 PNDPDNPNNNYIKPTKVNKNKEGLNIDGKEVLGASTNYEELTWDLQYKGDSSKEAIQNGFYVDDYPEE
 ALDVRPDLVKVADEKGNQVSGVSVQQYDSLEAAPKKVQDLLKANI TVKGAFQLFSADNPEEFYKQYVSTG
 TSLVITDPMTVKSEFGKTGGKYENKAYQIDFGNGYATEVVNNVPKITPKKDVTVSLDPTSENLDGQTVQL
 YQTFNYRLIGGFIPQNHSEELDYDFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGTDLTSQTTAET
 DATNGIVTVRFKEDFLQKISLDSPPQAETYLQMRRIAIGTFENTYVNTVNKVAYASNTVRTTTPIPRTPDK
 PTPIPTPKPKDPDKPETPKPKVPSPKVEDPSAPIFVSVGKELTTLPKTGTNDATYMPYLGLAALVGLGL
 GLAKRKED

SEQ ID NO: 17 amino acid sequence comprising PspA from *Streptococcus pneumoniae*
 Genbank reference GI 282335

MNKKKMILTSLASVAILGAGFVASQPTVVRAEESPVASQSKAEKDYDAKKDAKNAKKAVERDAQKALDDAK
 AAQKKYDEDQKKTEEKAALKAASEEMDKAVAAVQQAAYLAYQQAATDKAAKDAADKMIDEAKKREEEAKTKF
 NTVRAMVVPEPEQLAETKKKSEAKQKAPELTKKLEEAkakLEEAEEKATEAKQKVDAEEVAPQAKIAELE
 NQVHRLEQELKEIDSESEDYAKEGFRAPLQSKLDAKKAKLSKLEELSDKIDELDAEIAKLEDQLKAAEEN
 NNVEDYFKEGLEKTIAAKKAELEKTEADLKAVNEPEKPAPAPETPAPEAPAEQPKPAPAPQAPAPKPEK
 PAEQPKPEKTDDQQAEDYARRSEEEYNRLTQQQPPKAEPAPAPKTGWKQENGMYFYNTDGSMATGWLQ
 NNGSWYYLNSNGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNAN
 GAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWVKG
 DTWYYLEASGAMKASQWFKVSDKWYYVNLGALAVNTTVDGYKVNANGEWV

SEQ ID NO: 18 amino acid sequence comprising a portion of Se89.9 of *Streptococcus equi*
 Genbank reference GI 2330384

ESDIVDATRFSTTEIPKSGQVIDRSASIQALTNDIASIKGKIASLESRLADPSSEAEVTAAQAKISQLQH
 QLEAAQAKSHKLDQQVEQLANTKDSLRTQLLAAKEEQAKLNDKALALLASSKATLHKLEAAMEEAKA
 RVAGLASQKAQLEDLLAFEKNPNRIELAQEKVAAAKKALADTEDKLLAAQASLSDLQAQRARLQLSIATI

SEQ ID NO: 19 polynucleotide sequence comprising GST-40-HIS

CTGGTTCGCGTGGATCCCATATGAGTGTAGGCGTATCTCACCAGTCAAAGCAGATGATAGAGCCTCAGG
 AGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAA
 CTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACA
 AAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACA
 AGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAG
 AGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACTGCATTGTCA
 GAACAAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAACGTCTGA
 ACAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTA
 ATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAA
 GTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAG
 TCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAAATAACCATGAAAGCACCGCAAG
 GCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTAT
 TACAAAGAGCATGCAGATCAAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATAT
 TCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAATGAGCTAGCGCAGT

SEQUENCE LISTING

TTGCAGCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCA
 CAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACATCATGGTAATACAAGACCATCATTTGTCTA
 CGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCG
 GAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACT
 GTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAA
 TACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGAT
 TTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCAT
 CAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGT
 ATCTGATACTATTGTCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTCATCAAG
 AAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAG
 TCAGACAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGC
 AGCTAAAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAG
 CCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAA
 GCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGA
 TAATACTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTAC
 AAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTA
 GCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACC
 TCTTACGGGCGTAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAG
 AAACGAAACAACTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTT
 GTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCC
 CTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTA
 CTCAAAGAGCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTCGGCCTCACAGGATTTAGGTTCCGTAAG
 GAATCTAAGGCGGCCCGCACTCGAGCACCACCACCACCACCACCAC

SEQ ID NO: 20 amino acid sequence comprising GST-40-HIS

L V P R G S H Met S V G V S H Q V K A D D R A S G E T K A S N T H D D S
 L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T
 K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E
 T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E
 Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N
 P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V
 K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I
 V G N N T Met K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H Met I N S V R R Q L G L P P V T V T A G S Q
 E F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P
 H D K T I I E D S A G A S G L I R N D D N Met Y E N I G A F N D V H T V
 N G I K R G I Y D S I K Y Met L F T D H L H G N T Y G H A I N F L R V D
 K H N P N A P V Y L G F S T S N V G S L N E H F V Met F P E S N I A N H
 Q R F N K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S
 S L E N R L S A I H Q E A D I Met A A Q A K V S Q L Q G K L A S T L K Q
 S D S L N L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R
 D Q S L A K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A
 H L Q Y L R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L
 L N A Q E A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N
 E K E Y R H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T
 T P L V Q E Met V K E T K Q L L E A S A R L A A E N T S L V A E A L V G
 Q T S E Met V A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T
 S N L I S D V D E S T Q R A L K A G V V Met L A A V G L T G F R F R K E
 S K A A A L E H H H H H H

SEQ ID NO: 21 polynucleotide sequence comprising 40a-HIS

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACACTACTGCTGAAATCAAC
 CACTTAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT

SEQUENCE LISTING

TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCATTTC
 GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
 TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTTCGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
 ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
 CTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
 CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
 GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
 TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCCTGATTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
 CTTAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGGCGCGCCGCACTCG
 AGCACCACCACCACCACCACCAC

SEQ ID NO: 22 amino acid sequence comprising 40a-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
 Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
 A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
 P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
 K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
 Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
 K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
 G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
 K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
 S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S
 T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
 D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
 K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
 H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
 L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
 S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
 P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
 L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I

SEQUENCE LISTING

T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 23 polynucleotide sequence comprising 40a-RR-HIS

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAA
CTCTCAGTCAACAAAAGCAGAAGCTGACAGAGCTTGCTACCGCTCTGACAAAACACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTGAGAACAACAAAAGCTAGCATTTC
GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAAACGTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAGGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGACAGGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTCGAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCTGATTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACATATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGtGCGGCCGCACTCG
AGCACCACCACCACCACCACCAC

SEQ ID NO: 24 amino acid sequence comprising 40a-RR-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S

SEQUENCE LISTING

T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I
T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 25 polynucleotide sequence comprising 40a-RR (nat)

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
CTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACTACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGAGACTGCATTGTGAGAACAACAAAGCTAGCATTTC
GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAAGTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAGGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACATCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGACAGGAGTGACAGCACTGGTGGCTAAAAAGCTCATTTGCAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAGt

SEQ ID NO: 26 amino acid sequence comprising 40a-RR (nat)

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P

SEQUENCE LISTING

Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R

SEQ ID NO: 27 polynucleotide sequence comprising HIS-40a NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
AGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGG
CAAAGGCAACTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACC
GCTCTGACAAAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAAC
CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
A⁵CAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACT
GCATTGTCAGAACAAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAA
AACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
AAACGGCTAATGATAATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGC
AGAAGTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAG
CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
AATAATTATTACAAAGAGCATGCAGATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATA
CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGC
TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACA
GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATC
ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTATGGTGTGTTGGGCCTCATGATAAACTATTATTGAAG
ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGAT
GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
ACACGGAAATACATACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTT
ACCTTGGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATATGCCCAAAGAGT
AGGCACTGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTA
TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGA
ATTACTAGCAGCTAAAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGAGTGACAGCACTGGTG
GCTAAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGA
GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
CAGCCTTACAAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGT
AGCTCCACCTCTTACGGGCGTAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAA
TGGTTAAAGAAACGAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
GAAGCGCTTGTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
ATGAAAGTACTCAAC³Gt

SEQ ID NO: 28 amino acid sequence comprising HIS-40a NH

SEQUENCE LISTING

M G S H H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A B L T E L A T A
L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
D E S T Q R

SEQ ID NO: 29 polynucleotide sequence comprising HIS-40a CH

ATGGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAG
TAATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTG
AAAAAACTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACGAAAACTACTGCTGAA
ATCAACCACTTAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAA
TACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTG
AAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGC
ATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAA
GCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAG
CATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAAATCAAAAAGCTAAAGTTAAAAAGCAATTG
ACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGCTCTTAAATCCTC
AGCTCCGCTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAG
AACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCA
GATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAA
TCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGA
TTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGA
TTACTTAGTACCAGCTATAAGAAAACATGTTGTAATACAAAGACCATCATCTGTCTACGGACAGCCAGGGGT
ATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCA
TTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAA
CGTGGTATTTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGC
TATTAACCTTTTACGTGTAGATAAACATAACCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATG
TAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAG
ACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGC
AGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGG
CAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAAT
CTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACA
AGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGA
CAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGCAATAT
CTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGA
TTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCA
GTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAA

SEQUENCE LISTING

TATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTGCAAGTAGCTCCACCTCTTACGGGCGTAAA
ACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACCTAT
TAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGGCCAAACCTCT
GAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATC
TTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAGCGTGCGGCCG
CACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 30 amino acid sequence comprising HIS-40a CH

M A S S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T
I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I
N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G
A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S
A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A
A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T B E
L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K
A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I
A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L
A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S
Y K K T H G N T R P S E V Y G Q P G V S G H Y G V G P H D K T I I E D S
A G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S
I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G
F S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G
S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E
A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D
T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A
L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N
R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K
Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T
V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q
L L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K
I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A
A L E H H H H H H

SEQ ID NO: 31 polynucleotide sequence comprising HIS-40a-RR NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
AGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGG
CAAAGGCAACTATTGATGCAGTTGAAAAAACTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACC
GCTCTGACAAAACTACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAAC
CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
ATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACT
GCATTGTCAGAACAAAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAA
AACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
AAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGC
AGAAGTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTTGTGGGTAATAATACCATGAAAG
CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
AATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATA
CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGC
TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTACGtGtCAATTAGGTCTACCACCAGTTACTGTTACA
GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATC
ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTTATGGTGTGGGCCCTCATGATAAACTATTATTGAAG
ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGAT
GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
ACACGGAAATACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCTAATGCGCCTGTTT
ACCTTGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGT

SEQUENCE LISTING

AGGCACTGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCTGGCTA
 TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
 CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGA
 ATTACTAGCAGCTAAAGCAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
 CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTG
 GCTAAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACC GCCTTCAAGTGATACGTGA
 GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
 CAGCCTTACAAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
 AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTGCAAGT
 AGCTCCACCTCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAA
 TGGTTAAAGAAACGAAACAAC TATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAAGCA
 GAAGCGCTTGTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
 TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTG
 ATGAAAGTACTCAACGt

SEQ ID NO: 32 amino acid sequence comprising HIS-40a-RR NH

M G S H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
 D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
 L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
 E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
 S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
 N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
 V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
 I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
 F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
 D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
 I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
 P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
 K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
 R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
 L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
 K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
 R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
 A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
 H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
 E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
 A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
 D E S T Q R

SEQ ID NO: 33 polynucleotide sequence comprising 40N-HIS

ATGCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCAGCAGATAGTTTACC
 AAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAAGCTCTCAGTCAACAAAAAG
 CAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAACCCTTAAAGAGCAGCAA
 GATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGAC
 GCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAG
 CAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCATTTTCAGCAGAACTACTCGAGCT
 CAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCC
 TGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGG
 CTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAA
 GCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCAT
 TGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTG
 GTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGT
 CCAGGTAATCAATTAAATCAATACCAAGCGGCCGCACTCGAGCACCACCACCACCACCAC

SEQUENCE LISTING

SEQ ID NO: 34 amino acid sequence comprising 40N-HIS

M Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I
D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D
N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T
A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D
L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T
K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L
A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E
E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q
L N Q Y Q A A A L E H H H H H H H

SEQ ID NO: 35 amino acid sequence comprising GAS 117

MTLKKHYLLSLLALVTVGAAFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDL
GRHYSSYYYNLRTVMGLSSEQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 36 polynucleotide sequence encoding GAS 117

ATGACACTAAAAAACACTATTATCTTCTCAGCCTGCTAGCTCTTGTAACGGTTGGTGCTGCCTTTAACAC
AAGCCAGAGTGTGAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTTGACTGATGAAAAATCAC
ACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCTACCAAATGACCTA
GGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGACTATCAAGTGAGCAAGACAT
TGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATTAA

SEQ ID NO: 37 amino acid sequence comprising GAS 117 leader sequence

TLKKHYLLSLLALVTVGA

SEQ ID NO: 38 amino acid sequence comprising fragment of GAS 117 where leader sequence is removed

AFNTSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDLGRHYSSYYYNLRTVMGLSS
EQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 39 amino acid sequence comprising GAS 130

MSHMKKRPEVLSPAGTLEKLKVAIDYGADAVFVGGQAYGLRSRAGNFSMEELQEGIDYAHARGAKVYVAAN
MVTHEGNEIGAGEWFRQLRDMGLDAVIVSDPALIVICSTEAPGLEIHLSTQASSTNYETFEFWKAMGLTRV
VLAREVNMAELAEIRKRTDVEIEAFVHGAMCISYSGRCVLSNHMSHRDANRGGSQSCRWKYDLYDMPFGG
ERRSLKGEIPEDYSMSSVDMCMIDHIPDLIENGVDLSKIEGRMKSIIHYVSTVTNCYKAAVGAYMESPEAFY
AIKEELIDELWKVAQRELATGFYGIPTENEQLFGARRKIPOYKFVGEVAFDSASMTATIRQRNVIMEGD
RIECYGPGRHFETVVKDLHDADGQKIDRAPNPMELLTISLPREVKPGDMIRACKEGLVNLYQKDGTSTKV
RT

SEQ ID NO: 40 polynucleotide sequence encoding GAS 130

ATGTCACATATGAAAAACGTCCCGAGGTCTTATCACCTGCTGGAACACTTGAAAAATTAAAAGTTGCGAT
TGACTATGGCGCAGATGCTGTTTTTGTGTTGGAGGGCAGGCCCTATGGCCTAAGAAGCCGCGCTGGTAACCTCT
CTATGGAAGAATTGCAAGAAGGCATTGATTATGCACATGCGCGTGGAGCTAAGGTCTATGTTGCTGCTAAC
ATGGTTACCCACGAAGGGAACGAAATTGGTGCGGGCGAGTGGTTTCGTCAACTGCGTGATATGGGGCTTGA
TGCGGTCATTGTTTCAGATCCAGCCTTGATTGTTATTTGTTCAACAGAAGCCCCAGGTTTGGAAATTCATT
TGTCACGCAAGCTTCATCTACCAATTACGAGACCTTTGAATTTTGGAAAGCCATGGGCTTGACCCGAGTT
GTTTTAGCTCGCGAGGTTAATATGGCCGAGTTAGCAGAAATCCGCAAGCGGACAGATGTGGAATTTGAAGC
CTTTGTCCATGGAGCCATGTGTATCTCTTATTACAGGCCGCTGTGTTTTGTCAAACCACATGAGTCACCGTG
ATGCCAACAGGGGCGGCTGCTCACAGTCTTGCCGCTGGAAGTATGATTTGTATGACATGCCATTTGGAGGA
GAGCGCCGCTCCTTAAAAGGGGAAATTCAGAAGACTATTCTATGTCCTCTGTTGACATGTGTATGATTGA
CCATATTCCTGACCTGATTGAAAATGGGGTTGATAGCTTAAAAATTGAAGGCCGAATGAAATCTATCCACT
ACGTCTCAACCGTAACCAACTGTTACAAGCGGCTGTAGGTGCTTACATGGAAAGCCAGAAGCTTTTTAT
GCTATCAAAGAGGAATTGATTGACGAGTTGTGGAAGGTTGCCAGCGCGAGTTGGCTACAGGTTTTTACTA
TGGTATCCCAACTGAAAATGAACAATTATTTGGTGCTCGCCGCAAAATTCACAATATAAATTTGTGCGGAG
AAGTAGTTGCCTTTGACTCAGCTAGCATGACAGCGACCATTCGTCAGCGTAATGTCATCATGGAAGGCGAT

SEQUENCE LISTING

CGGATTGAATGTTATGGACCAGGTTTCCGTCATTTTGAAACGGTTGTTAAGGACTTACATGATGCGGATGG
 CCAAAAGATTGACCGTGCCCCAAATCCAATGGAACCTTAACCATCTCTTTACCGAGAGAAGTTAAGCCAG
 GGGATATGATTAGGGCTTGCAAGGAAGGTCTGGTTAACCTCTATCAAAAAGATGGCACCAGTAAACTGTT
 AGAACATAG

SEQ ID NO: 41 amino acid sequence comprising GAS 277

MTTMQKTISLLSLALLIGLLGTSGKAISVYAQDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV
 RQPTQATITLKDASDNTINSWVYTMAAQRRFTAWFDLTGQKSGDYHVTVTVHTQEKA VTGQSGTVHFDQN
 KARKTPTNMQQKDTSKAMTNSVDVDTKAQTNQSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPTASN
 SQKNGSNKTKMLVDKEEVKPTSKRGFPWVLLGLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 42 polynucleotide sequence encoding GAS 277

ATGACAAC TATGCAAAAACAATTAGCTTATTATCACTAGCTTTACTTATTGGTTTGCTGGGGACTTCTGG
 CAAAGCCATATCTGTGTATGCACAAGATCAGCACACTGATAATGTTATAGCTGAATCAACTATTAGTCAGG
 TCAGTGTTGAAGCCAGTATGCGTGGAACAGAACCTTATATTGATGCTACAGTCACCACAGATCAACCTGTC
 AGACAACCAACTCAGGCAACGATAACACTTAAAGACGCTAGTGATAATACTATTAATAGTTGGGTATATAC
 TATGGCAGCGCAACAGCGTCGTTTACAGCTTGGTTTGATTAACTGGACAAAAGAGTGGTGACTATCATG
 TAACTGTCACCGTTCATACTCAAGAAAAGGCAGTAACTGGTCAATCAGGAAC TGTTCATTTTGATCAAAAC
 AAAGCTAGAAAAACACCAACTAATATGCAACAAAAGGATACTTCTAAAGCAATGACGAATTCAGTCGATGT
 AGACACAAAAGCTCAAACAAATCAATCAGCTAACCAAGAAATAGATTCTACTTCAAATCCTTTCAGATCAG
 CTACTAATCATCGATCAACTTCCTTAAAGCGATCTACTAAAAATGAGAACTTACACCAACTGCTAGTAAT
 AGCCAAAAAACGGTAGCAACAAGACAAAAATGCTAGTGGACAAAGAGGAAGTAAAACCTACTTCAAAAAG
 AGGATTCCCTTGGGTCTTATTAGGTCTAGTAGTCAGTTTAGCTGCAGGTTTATTTATAGCTATTCAAAAAG
 TATCTAGACGAAAATAA

SEQ ID NO: 43 amino acid sequence comprising N-terminal leader sequence of GAS 277

TTMQKTISLLSLALLIGLLGTSGKAISVYA

SEQ ID NO: 44 amino acid sequence comprising fragment of GAS 277 where N-terminal leader sequence is removed

QDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV RQPTQATITLKDASDNTINSWVYTMAAQRR
 FTAWFDLTGQKSGDYHVTVTVHTQEKA VTGQSGTVHFDQNKARKTPTNMQQKDTSKAMTNSVDVDTKAQTN
 QSANQEIDSTSNPFRSATNHRSTSLKRSTKNEKLTPTASNSQKNGSNKTKMLVDKEEVKPTSKRGFPWVLL
 GLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 45 amino acid sequence comprising GAS 236

MTQMNYTGKVKRVAI IANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELD
 KVRFGIHTGHLGFYTDYRDFEVDKLIDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKT
 MVADVIINHVKFESFRGDGISVSTPTGSTAYNKSLGGAVLHPTIEALQLTEISSLN RVFRTLGSIIIPK
 KDKIELVPKRLGIY TISIDNKTYQLKNVT KVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 46 polynucleotide sequence encoding GAS 236

ATGACACAGATGAATTATACAGGTAAGGTA AAAACGAGTTGCTATTATTGCAAATGGTAAGTACCAAAGTAA
 ACGCGTCGCCTCAAAC TTTTCTCCGTATTTAAAGATGATCCTGATTCTATCTTTCAAAGAAAATCCGG
 ATATTGTGATTTCTATTGGCGGAGATGGGATGCTCTTATCTGCCTTTCACATGTATGAAAAAGAATTAGAT
 AAGGTACGTTTGTAGGAATCCACACCGGTCATCTTGGCTTTTATACCGATTATAGGGATTTTGAAGTTGA
 TAAATTAATTGATAATTTAAGAAAAGACAAGGGAGAACAAATCTCTTATCCGATTTTAAAAGTTGCTATTA
 CTTTAGATGATGGTCGTGTGGTTAAAGCGCGTGCTTTGAATGAAGCGACGGTTAAGCGTATTGAAAAACG
 ATGGTAGCAGATGTTATTATTAACCATGTCAAATTTGAAAGCTTCCGAGGTGATGGGATTT CAGTATCGAC
 CCCGACAGGGAGCACAGCCTACAATAAATCTTTAGGTGGTGCTGTCTTGCATCCGACGATTGAAGCGCTGC
 AATTGACGGAAATTTCCAGTCTTAATAACCGTGCTTTAGAACCTTGGGCTCATCAATCATTATTCCCAA
 AAAGATAAGATTGAGTTAGTGCCAAAACGATTAGGAATTTATACCATTTCCATTGATAATAAACCTATCA
 GTTAAAAAATGTGACGAAGGTGGAGTATTTTATCGACGATGAGAAAATTCATTTTGTTTCTCTCCGAGTC
 ATACGAGCTTTTGGGAAAGGGTCAAGGATGCCTTTATTGGAGAGATTGACTCATGA

SEQUENCE LISTING

SEQ ID NO: 47 amino acid sequence comprising N-terminus leader sequence of GAS 236
MTQM

SEQ ID NO: 48 amino acid sequence comprising a fragment of GAS 236 where the N-terminal leader sequence is removed

NYTGKVKRVAI IANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELDKVRF
VGIHTGHLGFYTDYRDFEVDKLIDNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKTMTVAD
VIINHVKFESFRGDGISVSTPTGSTAYNKS LGGAVLHPTIEALQLTEISSLNNRVFRTLGSIIIPKKDKI
ELVPKRLGIYTI SIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 49 amino acid sequence comprising GAS 389

MRNEMAKIMNVTGEEVIALAATYMTKADVAFVAKALAYATAAHFYQVRKS GEPYIVHPIQVAGILADLHLD
AVTVACGFLHDVVEDTDITLDEIEADFGHDARDIVDGVTKLGEVEYKSHEEQLAENHRKMLMAMSKDIRVI
LVKLADRLHNMRTLKHLRDKDKQERISRETMEIYAPLAHRLGISRIKWELEDLAFRYLNETEFYKISHMMKE
KRREREALVEAIVSKVKTYTTTQQGLFGDVYGRPKHIYSIYRKMRDKKRFDQIFDLIAIRCVMETQSDVYA
MVGYIHELWRPMPGRFKDYIAAPKANGYQSIHTTVYGPKGPIEQIRTKDMHQVAEYGVAAHWAYKKGVRG
KVNQAEQAVGMNWIKELEVELQDASNGDAVDFVDSVKEDIFSERIYVFTPTGAVQELPKESGPIDFAYAIHT
QIGEKATGAKVNGRMVPLTAKLKTGDVVEIITNANSFGPSRDWVKLVKTNKARNKIRQFFKNQDKELSVNK
GRDLLVSYFQEQGYVANKYLDKKRIEAILPKVSVKSEESLYAAVGFGDISPISVFNKLTEKERREEERAKA
KAEAEELVKGGEVKHENKDV LKVRSENGV I IQGASGLLMRIAKCCNPVPGDPIDGYITKGRGIAIHRSDCH
NIKSQDGYQERLIEVEWDLDNSSKDYQAEIDIYGLNRSGLLNDVLQILSNSTKSISTVNAQPTKDMKFANI
HVSFGIPNLTHLTTVVEKIKAVPDVYSVKRTNG

SEQ ID NO: 50 polynucleotide sequence encoding GAS 389

ATGAGGAACGAAATGGCAAAAATAATGAACGTAACAGGAGAAGAAGTCATTGCCTTAGCGGCCACCTATAT
GACCAAGGCTGATGTGGCTTTTGTGGCAAAGGCTTTAGCATATGCAACAGCGGCCCATTTCTACCAAGTGA
GAAAGTCAGGCGAACCCTATATCGTCCATCCGATTCAGGTGGCGGGGATTCTGGCTGATTTGCATCTGGAT
GCTGTGACAGTTGCTTGTGGCTTTTACATGATGTCGTAGAAAGATACGGATATTACCTTAGATGAGATCGA
AGCAGACTTTGGCCATGATGCTCGTGATATCGTTGATGGTGTACCAAGTTAGGTGAAGTTGAGTACAAAT
CTCATGAGGAGCAACTCGCCGAAAACCATCGCAAAATGCTGATGGCTATGTCCAAAGATATTTCGCGTGATT
TTGGTGAAATTGGCTGACCGCCTGCATAATATGCGCACCCCTCAAACATTTGCGCAAGGACAAACAAGAGCG
CATTTTCGCGCGAAACCATGGAAATCTATGCCCCCTTGGCGCATCGTTTGGGGATTAGTCGCATCAAATGGG
AACTAGAAGATTTGGCTTTTCGTTACCTCAATGAAACCGAATTTTACAAAATTTCCCATATGATGAAAGAA
AAACGTCGCGAGCGTGAAGCTTTGGTAGAGGCTATTGTGTCAGTAAGGTCAAACCTATACGACACAACAAGG
GTTGTTTGGAGATGTGTATGGCCGACCAAAACACATTTTATTCGATTTATCGGAAAATGCGGGACAAAAGA
AACGATTCGATCAGATTTTGTATCTGATTGCCATTCGTTGTGTCATGGAAACGCAAAGCGATGTCTATGCT
ATGGTTGGCTATATTTCATGAGCTTTGGCGTCCCATGCCAGGCCGCTTCAAGGATTATATTGCAGCTCCTAA
AGCTAATGGCTACCAGTCTATTTCATACCACCGTGTATGGGCCAAAAGGACCTATTGAGATTCAAATCAGAA
CTAAGGACATGCATCAAGTGGCTGAGTACGGGGTTGCTGCTCACTGGGCTTATAAAAAAGGCGTGCGTGGT
AAGGTCAATCAAGCTGAGCAAGCCGTTGGCATGAACTGGATCAAAGAGCTGGTAGAATTGCAAGATGCCTC
AAATGGCGATGCAGTGGACTTTGTGGATTCGGTCAAAGAAGACATTTTTTCTGAACGGATTTATGTCTTTA
CACCGACAGGGGCGGTTTCAGGAGTTACCAAAAGAATCAGGTCTTATTGATTTTGTCTTATGCGATCCATACG
CAAATCGGTGAAAAAGCAACAGGTGCCAAAGTCAATGGACGTATGGTTCTCTCACTGCCAAGTTAAAAAC
AGGAGATGTGGTTGAAATCATCACC AATGCCAATTCCTTTGGCCCTAGTCGAGACTGGGTAAACTGGTCA
AAACCAATAAGGCTCGCAACAAAATTCGTCAGTTCTTTAAAAATCAAGACAAGGAATTGTCAGTGAATAAA
GGCCGTGATTTGTTGGTGTCTTATTTTCAAGAGCAGGGCTACGTTGCCAATAAATACCTTGACAAAAACG
CATTGAAGCCATCCTTCCAAAAGTCAGTGTGAAGAGCGAAGAATCACTCTATGCAGCCGTTGGGTTTGGTG
ACATTAGTCCTATCAGTGTCTTTAACAAGTTAACCGAAAAAGAGCGCCGTGAAGAAGAAAGGGCCAAGGCT
AAAGCAGAAGCTGAAGAATTGGTTAAGGGCGGTGAGGTCAAACACGAAAACAAAGATGTGCTCAAGGTTCTG
CAGTGAAAATGGAGTCATTATCCAAGGAGCATCAGGCCTCTTGATGCGGATTGCCAAGTGTTGTAATCCTG
TACCTGGTGATCCTATTGACGGCTACATTACCAAAGGGCGTGGCATTGCGATTACAGATCGGACTGTCAT
AACATTAAGAGTCAAGATGGCTACCAAGAACGCTTGATTGAGGTGAGTGGGATTTGGACAATTCGAGTAA
AGATTATCAGGCTGAAATTGATATCTATGGGCTCAATCGTAGTGGTCTGCTTAATGATGTGCTCCAAATTT
TATCAAACCTCAACCAAGAGCATATCGACAGTCAATGCTCAGCCGACCAAGGACATGAAGTTTGCTAATATT
CACGTGAGCTTTGGCATTCCAAATCTGACGCATCTGACCACTGTTGTGCAAAAAATCAAGGCAGTTCCAGA
TGTTTATAGCGTGAAGCGGACCAATGGCTAA

SEQUENCE LISTING

SEQ ID NO: 51 amino acid sequence comprising GAS 504

MKTRITELLNIDYPIFQGGMAWVADGDLGAVSNAGGLGIIGGNAPKEVVKANIDRVKAITDRPFGVNIM
 LLSPFADDIVDLVIEEGVKVVTGAGNPGKYMERLHQAGIIVVPVPSVALAKRMEKLGVDVIAEGMEAG
 GHIGKLTTMSLVRQVVEAVSIPVIAAGGIADGHGAAAFLGAEAVQIGTRFVVAKESNAHQNFKDKILAA
 KDIDTVISAQVVGHFVRSIKNKLTSAYAKAEKAFLIGQKTATDIEEMGAGSLRHAVIEGDVNGSVMAGQI
 AGLVRKEESCETILKDIYYGAARVIQNEAKRWQSVSIEK

SEQ ID NO: 52 polynucleotide sequence encoding GAS 504

ATGAAAACACGTATTACAGAATTACTTAATATTGATTACCCCATTTTCAAGGAGGAATGGCTTGGGTGTC
 TGATGGTGATTAGCAGGTGCAGTTTCTAATGCTGGTGGTTAGGCATTATAGGTGGTGGCAATGCTCCCA
 AAGAAGTCGTTAAAGCTAATATTGATCGTGTCAAAGCTATTACTGATAGACCTTTTGGGGTTAATATCATG
 CTTTTATCTCCTTTTGCTGATGATATCGTTGATCTGGTCATTGAAGAAGGTGTTAAAGTAGTAACAACAGG
 CGCAGGAAATCCAGGAAAGTATATGGAAAGACTGCACCAGGCGGGTATAATCGTTGTTCTGTTGTCCCAA
 GCGTTGCGCTAGCCAAACGTATGGAAAGCTTGGGGTAGATGCTGTTATTGCTGAGGGTATGGAAGCTGGA
 GGACATATTGGCAAGTTAACGACTATGTCTTTAGTAAGACAAGTTGTTGAAGCGGTTTCGATTCTGTTCAT
 TGCGGCAGGTGGTATAGCTGATGGTCATGGTGCAGCAGCAGCATTTATGTTAGGAGCAGAGGCTGTTCAAA
 TTGGAACCTCGCTTTGTTGTTGCTAAAGAATCCAATGCTCACCAAATTTTAAAGATAAAATCTTAGCAGCA
 AAAGATATTGATACGGTGATTCTGCGCAGGTGTGGGCCACCTGTCCGTTCTATTAAAAATAAATTGAC
 CTCAGCTTACGCTAAAGCAGAAAAAGCATTTTTAATTGGTCAAAAAACAGCTACTGATATTGAAGAAATGG
 GAGCAGGATCGCTTCGACACGCTGTTATTGAAGGCGATGTAGTCAATGGATCTGTTATGGCTGGCCAAATT
 GCAGGGCTTGTGAGAAAAGAAGAAAGCTGTGAAACGATTTTAAAGATATTTATTATGGTGCAGCTCGTGT
 TATTCAAAATGAAGCTAAGCGCTGGCAATCTGTTTCAATAGAAAAGTAG

SEQ ID NO: 53 amino acid sequence comprising GAS 509

MTKIYKTITELVGQTPIIKLNRLIPNEADVVKLEAFNPGSSVKDRIALSMIEAAEAEGGLISPGDVIIIE
 PTSGNTGIGLAWVGAAGYRVIIIVMPETMSLERRQIIQAYGAELVLTPGAEGMKGAIAKAETLAIELGAW
 MPMQFNPNPANSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTSLGVSHVLKKANPETVIYAVEAEESAV
 LSGQEPGPHKIQGISAGFIPNTLDTKAYDQIIIRVKSDALETARLTGAKEGFLVGISSGAALYAAIEVAK
QLGKGKHVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 54 polynucleotide sequence encoding GAS 509

ATGACTAAAATTTACAAACTATAACAGAATTAGTAGGTCAAACACCTATTATCAAACCTTAACCGTTTAA
 TTCCAAACGAAGCTGCTGACGTTTATGTAAATTAGAAGCTTTTAACCCAGGATCTTCTGTAAAGATCG
 TATTGCTTTATCGATGATTGAAGCTGCTGAAGCTGAAGGTCTGATAAGTCTTGGTGACGTTATTATCGAA
 CCAACAAGTGGTAATACAGGTATTGGTCTTGCATGGGTAGGTGCTGCTAAAGGGTATCGAGTCATTATTG
 TTATGCCCGAAACTATGAGCTTGGAAAGACGGCAAATCATTACAGGCTTATGGTGCAGAGCTTGTCTTAAC
 ACCTGGAGCAGAAGGTATGAAAGGGGCTATTGCAAAGCTGAACTTTAGCAATAGAACTAGGTGCTTGG
 ATGCCTATGCAATTTAATAACCTTGCCAATCCAAGCATCCATGAAAAACAACAGCTCAAGAAATTTTGG
 AAGCTTTTAAGGAGATTTCTTTAGATGCATTCGTATCTGGTGTGGTACTGGAGGAACACTTTCTGGTGT
 TTCACATGTCTTGAAAAAAGCTAACCTGAACTGTTATCTATGCTGTTGAAGCTGAAGAATCTGCTGTC
 TTATCTGGTCAAGAGCCTGGACCACATAAAATTCAAGGTATATCAGCTGGATTTATCCCAAACACGTTAG
 ATACCAAAGCCTATGACCAAATTATCCGTGTAAATCGAAAGATGCTTTAGAACTGCTCGACTAACAGG
 AGCTAAGGAAGGCTTCCTGGTTGGGATTTCTTCTGGAGCTGCTCTTTACGCCGCTATTGAAGTCGCTAAA
CAGTTAGGAAAAGGCAAACATGTGTTAACTATTTTACCAGATAATGGCGAACGCTATTTATCGACTGAAC
TCTATGATGTACCAGTAATTAAGACGAAATAA

SEQ ID NO: 55 amino acid sequence comprising C-terminus transmembrane region of GAS 509

FLVGISSGAALYAAIEVAKQLGKGKHVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 56 amino acid sequencing comprising a fragment of GAS 509 where the C-terminal transmembrane region is removed

MTKIYKTITELVGQTPIIKLNRLIPNEADVVKLEAFNPGSSVKDRIALSMIEAAEAEGGLISPGDVIIIEP
 TSGNTGIGLAWVGAAGYRVIIIVMPETMSLERRQIIQAYGAELVLTPGAEGMKGAIAKAETLAIELGAWMP

SEQUENCE LISTING

**MQFNPNPANSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTLSGVSHVLKKANPETVIYAVEABESAVLSG
QEPGPHKIQGISAGFIPNTLDTKAYDQIIRVKS KDALETARLTGAKEG**

SEQ ID NO: 57 amino acid sequence comprising GAS 366

**MKVISNFKQNKILILGLAKSGEAAKLLTKLGALVTVNDSKPFQNPAAQALLEEGIKVICGSHPVVELLDE
NFEYMVKNPGIPYDNPMVKRALAKEIPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSAL
LSGNIGYPASKVVQKAIAGDTLVMELSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSEFEDYVAAKWMIQAQ
MTESDYILNANQEISATLAKTTKATVIPFSTQKVVDGAYLKDGLYFKEQAIIAATDLGVPGSHNIENAL
ATIAVAKLSGIADDIIAQCLSHFGGVKHLRQVRGQIKDITFYNDSKSTNILATQKALSGFDNSRLILIAGG
LDRGNEFDDLVPDLLGLKQMIILGESAERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANAS
SWDMYPNFVVRGDEFLATFDCLRGDA**

SEQ ID NO: 58 polynucleotide sequence encoding GAS 366

**ATGAAAGTGATAAGTAATTTTCAAACAAAAAATATTAATATTGGGGTTAGCCAAATCGGGCGAAGCAGC
AGCAAATTATTGACCAAACTTGGTGCTTTAGTGACTGTTAATGATAGTAAACCATTGACCAAAATCCAG
CGGCACAAGCCTTGTTGGAAGAGGGGATTAAGGTCATTTGTGGTAGCCACCCAGTAGAATTATTAGATGAG
AACTTTGAGTACATGGTTAAAAACCCTGGGATTCCTTATGATAATCCTATGGTTAAACGCGCCCTTGCAAA
GGAAATCCCATCTTGACTGAAGTAGAATTGGCTTATTTTCGTATCTGAAGCGCCTATTATCGGGATTACAG
GATCAAACGGGAAGACAACCACAACGACAATGATTGCCGATGTTTGAATGCTGGCGGGCAATCTGCACTC
TTATCTGGAAACATTGGTTATCCTGCTTCAAAGTTGTTCAAAGCAATTGCTGGTGATACTTTGGTGAT
GGAATTGTCCTCTTTTCAATTAGTGGGAGTGAATGCTTTTCGCCCTCATATTGCTGTCATCACTAATTTAA
TGCCGACTCACCTGGACTATCATGGCAGTTTTGAGGATTATGTTGCTGCTAAATGGATGATTCAAGCTCAG
ATGACAGAATCAGACTACCTTATTTTAAATGCTAATCAAGAGATTTTCAGCAACTCTAGCTAAGACCACCAA
AGCAACAGTGATTCCTTTTCAACTCAAAAGTGGTTGATGGAGCTTATCTGAAGGATGGAATACTCTATT
TTAAAGAACAGGCGATTATAGCTGCAACTGACTTAGGTGTCCAGGTAGCCACAACATTGAAAATGCCCTA
GCAACTATTGCAGTTGCCAAGTTATCTGGTATTGCTGATGATATTATTGCCAGTGCCCTTTCACATTTTGG
AGGCGTTAAACATCGTTTGCAACGGGTGGTCAAATCAAAGATATTACCTTCTACAATGACAGTAAGTCAA
CCAATATTTTAGCCACTCAAAAGCTTTATCAGGTTTTGATAACAGTCGCTTGATTTTGATTGCTGGCGGT
CTAGATCGTGGCAATGAATTTGACGATTTGGTGCCAGACCTTTTAGGACTTAAGCAGATGATTATTTGGG
AGAATCCGCAGAGCGTATGAAGCGAGCTGCTAACAAAGCAGAGGTCTCTTATCTTGAAGCTAGAAATGTGG
CAGAAGCAACAGAGCTTGCTTTTAAGCTGGCCCAACAGGCGATACTATCTTGCTTAGCCAGCCAATGCT
AGCTGGGATATGTATCCTAATTTTGAGGTTTCGTGGGGATGAATTTTGGCAACCTTTGATTGTTTAAGAGG
AGATGCCTAA**

SEQ ID NO: 59 amino acid sequence comprising N-terminal leader sequence of GAS 366

MKVISNFKQNKILILGLAKSGEAAA

SEQ ID NO: 60 amino acid sequence comprising a fragment of GAS 366 where the N-terminal leader sequence is removed

**KLLTKLGALVTVNDSKPFQNPAAQALLEEGIKVICGSHPVVELLDENFEYMVKNPGIPYDNPMVKRALAKE
IPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSALLSGNIGYPASKVVQKAIAGDTLVMEL
LSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSEFEDYVAAKWMIQAQMTESDYILNANQEISATLAKTTKA
TVIPFSTQKVVDGAYLKDGLYFKEQAIIAATDLGVPGSHNIENALATIAVAKLSGIADDIIAQCLSHFGG
VKHLRQVRGQIKDITFYNDSKSTNILATQKALSGFDNSRLILIAGGLDRGNEFDDLVPDLLGLKQMIILGE
SAERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANASWDMYPNFVVRGDEFLATFDCLRGDA**

SEQ ID NO: 61 amino acid sequence comprising GAS 159

**MRKLYSFLAGVLGVIVILTSLSFILQKKSGSGSQDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDNSN
EAMYT KIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTV
GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV
KAIVADEMKGYMIQGDAAIGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNLF
INRPENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVDNLGSRWLGIYNDLYLQFKMY
RK**

SEQUENCE LISTING**SEQ ID NO: 62** polynucleotide sequence encoding GAS 159

ATGCGTAAACTTTATTCCTTTCTAGCAGGAGTTTGGGTGTTATTGTTATTTTAACAAGTCTTCTTTTCAT
 CTTGCAGAAAAAATCGGGTTCTGGTAGTCAATCGGATAAATTAGTTATTTATAACTGGGGAGATTACATTG
 ATCCAGCTTTGCTCAAAAAATTCACCAAAGAAACGGGCATTGAAGTGCAGTATGAAACTTTCGATTCCAAT
 GAAGCCATGTACACTAAAATCAAGCAGGGCGGAACCACTTACGACATTGCTGTTCTTAGTGATTACACCAT
 TGATAAAATGATCAAAGAAAACCTACTCAATAAGCTTGATAAGTCAAATTAGTTGGCATGGATAATATCG
 GGAAAGAATTTTATAGGGAAAAGCTTTGACCCACAAAACGACTATTCTTTGCCTTATTTCTGGGGAACCGTT
 GGGATTGTTTATAATGATCAATTAGTTGATAAGGCGCCTATGCACTGGGAAGATCTGTGGCGTCCAGAATA
 TAAAAATAGTATTATGCTGATTGATGGAGCGCGTGAAATGCTAGGGGTTGGTTTAACAACCTTTTGGTTATA
 GTGTGAATTCTAAAAATCTAGAGCAGTTGCAGGCAGCCGAGAGAAAACCTGCAGCAGTTGACGCCGAATGTT
 AAAGCCATTGTAGCAGATGAGATGAAAGGCTACATGATTCAAGGTGACGCTGCTATTGGAATTACCTTTTC
 TGGTGAAGCCAGTGAGATGTTAGATAGTAACGAACACCTTCACTACATCGTGCCTTCAGAAGGGTCTAACC
 TTTGGTTTGATAATTTGGTACTACCAAAAACCATGAAACACGAAAAAGAAGCTTATGCTTTTTTTGAACTTT
 ATCAATCGTCCTGAAAATGCTGCGCAAAATGCTGCATATATTGGTTATGCGACACCAAATAAAAAAGCCAA
 GGCCTTACTTCCAGATGAGATAAAAAATGATCCTGCTTTTTTATCCAACAGATGACATTATCAAAAAATTGG
 AAGTTTATGACAATTTAGGGTCAAGATGGTTGGGGATTATAATGATTTATACCTCCAATTTAAATGTAT
 CGCAAATAA

SEQ ID NO: 63 amino acid sequence comprising N-terminal leader sequence of GAS 159

MRKLYSFLAGVLGVIVILTSLSFI

SEQ ID NO: 64 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence is removed

LQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSNEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAIVADEMKGYMIQGDAAGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFLNFINRPENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVDNLGSRWLGIYNDLYLQFKMYRK

SEQ ID NO: 65 amino acid sequence comprising C-terminal hydrophobic sequence of GAS 159

WLGIYNDLYLQFKMYRK

SEQ ID NO: 66 amino acid sequence comprising a fragment of GAS 159 where the C-terminal hydrophobic region is removed

MRKLYSFLAGVLGVIVILTSLSFI LQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSN
 EAMYTKIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTG
 IVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNV
 KAIVADEMKGYMIQGDAAGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFLNFIN
 INRPENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVDNLGSR

SEQ ID NO: 67 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence and the C-terminal hydrophobic region is removed

LQKKSGSGSQSDKLVIYNWGDYIDPALLKKFTKETGIEVQYETFDSNEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPPQNDYSLPYFWGTGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKLQQLTPNVKAIVADEMKGYMIQGDAAGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFLNFINRPENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVDNLGSR

SEQ ID NO: 68 amino acid sequence comprising GAS 217

MAQRIIVITGASGGLAQAIWKQLPKEDSLILLGRNKERLEHCYQHIDNKECLELDITNPVAIEKMVAQIYQ
 RYGRIDVLINNAGYGAFKGFEEFSAQEIADMFOVNTLASIHFAFLIGQKMAEQGQGHILINIVSMAGLIASA
 KSSIYSATKFALIGFSNALRLELADKGVYVTTVNPGPIATKFFDQADPSGHYLESVGKFTLQPNQVAKRLV
 SIIGKNKRELNLPSLAVTHQFYTLFPKLSDY LARKVFNYK

SEQ ID NO: 69 polynucleotide sequence encoding GAS 217

SEQUENCE LISTING

ATGGCACAAAGAATCATTGTTATCACGGGAGCTTCTGGAGGACTGGCTCAGGCAATTGTTAAGCAGTTACC
 CAAGGAAGACAGCTTGATTTTATTAGGACGTAACAAAGAACGCCTAGAACACTGTTATCAGCATATTGACA
 ACAAAGAATGCCTCGAGTTGGATATTACCAATCCAGTAGCCATTGAGAAAATGGTCGCCCAGATTACCAG
 CGCTATGGCCGTATTGATGTCTTGATTAATAATGCTGGCTACGGAGCTTTCAAAGGCTTTGAAGAGTTTTC
 TGCCCAAGAAATAGCTGATATGTTTCAGGTTAACACCCTAGCGAGCATTCACTTTGCTTGCTTGATTGGTC
 AGAAAATGGCAGAGCAGGGGCAAGGTCACCTTATTAATATTGTGTCCATGGCAGGCTTGATTGCGTCAGCC
 AAATCGAGCATTATTTCAGCCACCAAGTTTGCCCTTATCGGATTTTCCAATGCCCTTCGCTTAGAATTAGC
 GGATAAAGGGGTTTACGTGACCACCGTGAATCCAGGTCCCATTTGCCACCAAGTTTTTTTGACCAAGCTGACC
 CGTCTGGACATTATTTGGAAAGCGTTGGTAAATTTACTCTCCAACCAATCAAGTGGCTAAGCGTTTGGTT
 TCTATTATCGGGAAAAATAAACGAGAATTGAATTTGCCCTTTAGTTTAGCGGTGACCCATCAATTTTACAC
 CCTTTTCCCTAAATTATCTGATTATCTTGCAAGAAAGGTATTTAATTATAAATGA

SEQ ID NO: 70 amino acid sequence comprising GAS 309

MIEKYLESSIESKQLIVLFFKTSYLPITEVAEKTGLTFLQLNHYCEELNAFFPGSLSMITIQKRMISCQFT
 HPFKETYLYQLYASSNVLQLLAFLIKNGSHSRPLTDFARSHFLSNSSAYRMREALIPLLRNFELKLSKNKI
 VGEERYRIRYLIALLYSKFGIKVYDLTQQDKNTIHSFLSHSSTHLKTSFWLSEFSFYDILLALSWKRHQS
 VTIPQTRIFQQLKKLFVYDSLKKSSHDIIETCYQLNFSAGDLDYLYLIYITANNSFASLQWTPEHIRQYQ
 LFEENDTFRLLLNPIITLLPNLKEQKASLVKALMFFSKSFLFNLQHFIPETNLFVSPYKGNQKLYTSLKL
 IVEEWMAKLPKGRDLNKHFLFCHYVEQSLRNIQPPLVVVFVASNFINAHLTDSFPRYFSDKSIDFHSY
 YLLQDNVYQIPDLKPDVITHSQLIPFVHHELTGKIAVAEISFDESILSIQELMYQVKEEFQADLTQOLT

SEQ ID NO: 71 polynucleotide sequence encoding GAS 309

TTGATAGAAAAATACTTGAATCATCAATCGAATCAAATGTCAGTTAATTGTCTTGTTTTTTAAGACATC
 TTATTTGCCAATAACTGAGGTAGCAGAAAAAACTGGCTTAACCTTTTTTACAATAAACCATTATTGTGAGG
 AACTGAATGCCTTTTTCCCTGGTAGTCTGTCTATGACCATCCAAAAAAGGATGATATCTTGCCAATTTACA
 CATCCTTTTTAAAGAACTTATCTTTACCAACTCTATGCATCATCTAATGTCTTACAATTACTAGCCTTTTT
 AATAAAAAATGGTTCCCACTCTCGTCCCCCTTACGGATTTTGCAAGAAGTCATTTTTTATCAAACCTCCTCAG
 CTTATCGGATGCGCGAAGCATTGATTCCTTTATTAAGAACTTTGAATTAAAACTCTCTAAGAACAAGATT
 GTCGGTGAGGAATATCGCATCCGTACCTCATCGCTCTGCTATATAGTAAGTTTGGCATTAAGTTTATGA
 CTTGACGCAGCAAGACAAAAACACTATTCATAGCTTTTTTATCCCATAGTTCCACCCACCTTAAACCTCTC
 CTTGGTTATCGGAATCGTTTTCTTTCTATGACATTTTATTAGCTTTATCGTGGAAGCGGCATCAATTTTCG
 GTAACATTATCCCCAAACCAGAATTTTTCAACAATTAAAAAAACTTTTTGTCTACGATTCTTTGAAAAAAG
 TAGCCATGATATTATCGAACTTACTGCCAACTAACTTTTCAGCAGGAGATTGACTACCTCTATTTAA
 TTTATATCACCGCTAATAATTCTTTTGCGAGCTTACAATGGACACCTGAGCATATCAGACAATATTGTCAA
 CTTTTTGAAGAAAATGATACTTTTCGCCTGCTTTTAAATCCTATCATCACTCTTTTACCTAACCTAAAAGA
 GCAAAAGGCTAGTTTAGTAAAGCTCTTATGTTTTTTTCAAATCATTCTTGTTTAATCTGCAACATTTTA
 TTCCTGAGACCAACTTATTCGTTTCTCCGTACTATAAAGGAAACCAAAACTCTATACGTCCTTAAAGTTA
 ATTGTCGAAGAGTGGATGGCCAACTTCCTGGTAAGCGTGACTTGAACCATAAGCATTTTTCATCTTTTTTG
 CCACTATGTGCGAGCAAAGTCTAAGAAATATCCAACCTCCTTTAGTTGTTGTTTTCGTAGCCAGTAATTTTA
 TCAATGCTCATCTCCTAACGGATTCTTTTCCAAGGTATTTCTCGGATAAAAGCATTGATTTTCATTCTAT
 TATCTATTGCAAGATAATGTTTATCAAATTCCTGATTTAAAGCCAGATTTGGTCATCACTCACAGTCAACT
 GATTCTTTTGTTCACCATGAACCTACAAAAGGAATTGCTGTTGCTGAAATATCTTTTGATGAATCGATTC
 TGTCTATCCAAGAATTGATGTATCAAGTTAAAGAGGAAAAATTCCAAGCTGATTTAACCAAGCAATTAACA
 TAA

SEQ ID NO: 72 amino acid sequence comprising GAS 372

MIQIGKLFAGRYRILKSIGRGGMADVYLANDLILDNEDVAIKVLRNTNYQTDQVAVARFQREARAMAELNHP
 NIVAIRDIGEEDGQQFLVMEYVDGADLKRYIQNHAPLSNNEVVRIMEEVLSAMTLAHQKGI VHRDLKPQNI
 LLTKEGVVKVTDGFI AVAFAETSLTQTN SMLGSVHYLSPEQARGSKATI QSDIYAMGIMLFEMLTGHI PYD
 GDSAVTIALQHFQKPLPSIIEENHNVPQALENVVIRATAKKLSDRYGSTFEMSRDLMTALSYNRSRERKII
 FENVESTKPLPKVASGPTASVKLSPTPTVLTQESRLDQTNQTDALQPPTKKKKSGRFLGTLFKILFSFFI
 VGVALFTYLILTKPTSVKVPNVAGTSLKVAKQELYDVGLKVGKIRQIESDTVAEGNVVRTPKAGTAKRQG
 SSITLYVSIGNKGFDMENYKGLDYQEAMNSLIETYGVPSKIKIERIVTNEY PENTVISQSPSAGDKFNPN
 GKSKITLSVAVSDTITMPMVTEYSYADAVNTLTALGIDASRIKAYVPSSSSSATGFVPIHSPSSKAIVSGQS
 PYYGTSLSLSDKGEISLYLYPEETHSSSSSSSSSTSSSNSSSINDSTAPGSNTELSPSETTSQTP

SEQUENCE LISTING**SEQ ID NO: 73** polynucleotide sequence encoding GAS 372

ATGATTCAGATTGGCAAATTATTTGCTGGTCGTTATCGCATTCTGAAATCTATTGGCCGCGGTGGTATGGC
GGATGTTTATTTAGCAAATGACTTGATCTTGGATAATGAAGACGTTGCAATCAAGGCTTGCGTACCAATT
ATCAAACAGATCAGGTAGCAGTTGCGCGTTTCCAACGAGAAGCGCGGGCCATGGCTGAATTGAACCATCCC
AATATTGTTGCCATCCGGGATATAGGTGAAGAAGACGGACAGCAATTTTATAGTAATGGAATATGTGGATGG
TGCTGACCTAAAGAGATACATTCAAAATCATGCTCCATTATCTAATAATGAAGTGGTTAGAATTATGGAAG
AAGTCCTTTCTGCTATGACTTTAGCCCACCAAAAAGGAATTGTACACAGAGATTTAAAACCTCAAAATATC
CTACTAACTAAGGAGGGTGTGTCAAAGTAACTGATTTTCGGCATCGCAGTAGCCTTTGCAGAAACAAGCTT
GACACAACTAATTTCGATGTTAGGCAGTGTTCATTACTTGTCTCCAGAACAGGCTCGCGGCTCCAAAGCGA
CGATTCAAAGTGATATTTATGCGATGGGGATTATGCTCTTTGAGATGTTGACAGGCCATATCCCTTATGAC
GGCGATAGTGCTGTTACGATTGCCTTGCAACATTTTCAAAGCCTCTTCCATCTATTATCGAGGAGAACCA
CAATGTGCCACAAGCTTTGGAGAATGTTGTTATTCGAGCAACAGCCAAGAAATTAAGTGATCGTTACGGGT
CAACCTTTGAAATGAGTCGTGACTTAATGACGGCGCTTAGTTATAATCGTAGTCGGGAGCGTAAGATTATC
TTTGAGAATGTTGAAAGTACCAAACCCCTCCCCAAAGTGGCCTCAGGTCCCACCGCTTCTGTAAAATTGTC
TCCCCCTACCCCAACAGTGTTAACACAGGAAAGTCGATTAGATCAAACATAATCAAACAGATGCTTTACAGC
CCCCCACCACAAAAGAAAAAAGTGGTCGTTTTTTTAGGTACTTTATTCAAATTCCTTTTTTCTTTCTTTATT
GTAGGTGTAGCACTCTTTACTTATCTTATACTAACTAAACCAACTTCTGTGAAAGTTCCTAATGTAGCAGG
CACTAGTCTTAAAGTTGCCAAACAAGAACTGTATGATGTTGGGCTAAAAGTGGGTAAAATCAGGCAAATTG
AGAGTGATACGGTTGCTGAGGGAAATGTAGTTAGAACAGATCCTAAAGCAGGAACAGCTAAGAGGCAAGGC
TCAAGCATTACGCTTTATGTGTCAATTGGAAACAAAGGTTTTGACATGGAAAACACAAAGGACTAGATTA
TCAAGAAGCTATGAATAGTTTGATAGAACTTATGGTGTTCCAAATCAAAAATCAAAATTGAGCGCATTG
TAACTAATGAATATCCTGAAAATACAGTCATCAGTCAATCGCCAAGTGCGGGTGATAAATTTAATCCAAAC
GGAAAGTCTAAAATTACGCTCAGTGTTGCTGTTAGTGATACGATCACTATGCCTATGGTAACAGAATATAG
TTATGCAGATGCAGTCAATACCTTAACAGCTTTAGGTATAGATGCATCTAGAATAAAAGCTTATGTGCCAA
GCTCTAGCTCAGCAACGGGCTTTGTGCCAATTCATTCTCCTAGTTCTAAAGCTATTGTCAGTGGTCAATCT
CCTTACTATGGAACGTCTTTGAGTCTGTCTGATAAAGGAGAGATTAGTCTTTACCTTTATCCAGAAGAAAC
ACACTCTTCTAGTAGCTCATCGAGTTCAACGTCAAGTTCAACAGTTCCTTCAATAAATGATAGTACTGCAC
CAGGTAGCAACACTGAATTAAGCCCATCAGAACTACTTCTCAACACCTTAA

SEQ ID NO: 74 amino acid sequence comprising GAS 39

MDLILFLLVLVLLGLGAYLLFKVNGLQHQLAQTLEGNADNLSQDMTYQLDTANKQQLLELTQLMNRQQAGL
YQQLTDIRDVLHRSLSDSRDRSDKRLEKINQQVNQSLKNMQESNEKRLEKMRQIVEEKLEETLKNRLHASF
DSVSKQLESVNKGLGEMRSVAQDVGTLNKVLSTNKTGRILGELQLGQI IEDIMTSSQYEREFVTVSGSSER
VEYAIKLPNGNGGGYIYLPIDSKFPLEDYRLEDAYEVGDKLAI EASRKALLAAIKRFAKDIHKKYLNPPPE
TTNFGVMFLPTEGLYSEVVRNASFFDSLREENIVVAGPSTLSALLNSLSVGFKTLNIQKNADDISKILGN
VKLEFDKFGGLLAKAQKQMNTANNTLDQLISTRINAIVRALNTVETYQDQATKSLNLMPLLEEENEN

SEQ ID NO: 75 polynucleotide sequence encoding GAS 39

ATGGACCTTATCTTGTTCCTTTTGGTCTTGGTCTCTTAGGTTTAGGGGCTTATCTGTTGTTCAAAGTCAA
CGGCCTTCAACATCAGCTTGCCCAACCCCTAGAAGGCAACGCGGATAATTTGTCTGACCAAATGACCTACC
AGTTGGATACAGCTAACAAACAACAATTGTTAGAGCTAACACAGCTGATGAACCGACAACAAGCAGGCCTT
TACCAACAATTAACAGATATTCGTGACGTCTTGCACCGTAGTTTGTCTGATAGTAGGGACCGGTCTGACAA
ACGCTTAGAAAAAATTAACCAGCAGGTCAACCAATCGCTCAAAAATATGCAAGAATCTAACGAAAAACGTT
TGGAGAAAAATGCGCCAGATCGTTGAAGAAAAATTGGAAGAAACCTTAAAAAATCGTCTGCACGCCTCTTTC
GATTCTGTATCCAAGCAACTAGAAAGTGTCAATAAAGGCTTGGGAGAAATGCGTAGCGTGGCTCAAGATGT
GGGTACTTTTAAATAAGGTTTTGTCCAATACCAAACACGAGGCATTTTAGGCGAACTTCAACTAGGCCAAA
TCATTGAGGATATCATGACATCAAGCCAGTACGAAAGAGAATTTGTAACGGTTAGTGGTTCTAGTGAACGC
GTAGAATATGCGATTAAAGCTCCCAGGAAATGGTCAAGGCGGTTATATTTACCTACCGATTGACTCAAAATT
CCCTCTTGAAGATTATTACCGATTAGAAGATGCTTACGAAGTTGGTGATAAACTGGCCATCGAGGCTAGCC
GAAAAGCACTTCTGGCAGCTATCAAACGCTTTGCCAAAGACATTCATAAAAAGTACTTGAACCCCCCAGAG
ACGACCAATTTTCGGAGTTATGTTCTTACCAACAGAAGGTCCTTATTCAGAAGTGGTCAGAAATGCGTCTTT
CTTTGATAGCCTTCGTGCGGAAGAAAATATTGTGGTTGCAGGCCCTTCGACCCTGTCTGCTTTGCTGAATT
CCTTATCTGTTGGTTTCAAGACCCTTAATATCCAAAAAATGCTGATGACATCAGTAAAATTTTAGGCAAT
GTCAAGTTAGAATTCGATAAATTTGGCGGCCTGCTTGCCAAGGCTCAAAAACAAATGAATACAGCTAATAA
TACGCTGGATCAGCTCATTTCAACAAGGACAAATGCCATTGTTTCGAGCCTTGAATACCGTTGAACTTATC
AAGACCAAGCAACAAATCTCTCTTGAACATGCCCTTATTAGAAGAGGAAAAATAATGAAATTA

SEQUENCE LISTING

SEQ ID NO: 76 amino acid sequence comprising GAS 42

MTKEKLVAFSQAHAEPWLQERRLAALAI PNLELPTIERVKFHRWNLGDGTLTENESLASVPDFIAIGDN
 PKLVQVGTQTVLEQLPMALIDKGVVFSDFYTALBEIPEVIEAHFGQALAFDEDKLAAYHTAYFNNSAAVLVY
 PDHLEITTPIEAIFLQSDSDVFPNKHVLVIAGKESKFTYLERFESIGNATQKISANISVEVIAQAGSQIK
 FSAIDRLGPSVTTYISRRGRLEKDANIDWALAVMNEGNVIADFDSDLIGQGSQADLKVVAASSGRQVQGID
 TRVTNYGQRTVGHILQHGVILERGTLTFNGIGHILKDAKGADAQQESRVLM LSDQARADANPILLIDENEV
 TAGHAASIGQVDPEDMYYLMSRGLDQETAERLVIRGFLGAVIAEIPIPSVRQEIIKVLDEKLLNR

SEQ ID NO: 77 polynucleotide sequence encoding GAS 42

ATGACAAAAGAAAACTAGTGGCTTTTTCGCAAGCCCACGCTGAGCCTGCTTGGCTGCAAGAACGGCGTTT
 AGCGGCATTAGAAGCCATTCCAAATTTGGAATTACCAACCATCGAAAGGGTTAAATTTACCGTTGGAATC
 TAGGAGATGGTACCTTAACAGAAAATGAAAGTCTAGCTAGTGTTCAGATTTTATAGCTATTGGAGATAAC
 CCAAGCTTGTTTCAGGTAGGCACGCAAACAGTCTTAGAACAGTTACCAATGGCGTTAATTGACAAGGGAGT
 TGTTTTTCAGTGATTTTTTATACGGCGCTTGAGGAAATCCCAGAAGTAATTGAAGCTCATTTTGGTCAGGCAT
 TAGCTTTTGATGAAGACAACTAGCTGCCTACCACACTGCTTATTTTAATAGCGCAGCCGTGCTCTACGTT
 CCTGATCACTTGGAATCACAACCTCTATTGAAGCTATTTTCTTACAAGATAGTGACAGTGACGTTCTCTT
 TAACAAGCATGTTCTAGTGATTGCAGGAAAAGAAAGTAAGTTCACCTATTTAGAGCGTTTTGAATCTATTG
 GCAATGCCACTCAAAGATCAGCGCTAATATCAGTGTAGAAGTGATTGCTCAAGCAGGCAGCCAGATTAAA
 TTCTCGGCTATCGACCGCTTAGGTCCTTCAGTGACAACCTATATTAGCCGTCGAGGACGTTTAGAGAAGGA
 TGCCAACATTGATTGGGCCTTAGCTGTGATGAATGAAGGCAATGTCATTGCTGATTTTGACAGTGATTGTA
 TTGGTCAGGGCTCACAAGCTGATTTGAAAGTTGTTGCAGCCTCAAGTGGTCGTCAGGTACAAGGTATTGAC
 ACGCGCGTGACCAACTATGGTCAACGTACGGTCGGTCATATTTTACAGCATGGTGTGATTTTGGAACGTGG
 CACCTTAACGTTTAACGGGATTGGTCATATTCTAAAAGACGCTAAGGGAGCTGATGCTCAACAAGAAAGCC
 GTGTTTTGATGCTTTCTGACCAAGCAAGAGCCGATGCCAATCCAATCCTCTTAATTGATGAAAATGAAGTA
 ACAGCAGGTCATGCAGCTTCTATCGGTCAGGTTGACCCTGAAGATATGTATTACTTGATGAGTCGAGGACT
 GGATCAAGAAACAGCAGAACGATTGGTTATTAGAGGATTCTAGGAGCGGTTATCGCTGAAATTCCTATTC
 CATCAGTCCGCCAAGAGATTATTAAGGTTTTAGATGAGAAATTGCTTAATCGTTAA

SEQ ID NO: 78 amino acid sequence comprising GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMAHPVQAEVISKRDYMTFRFGLGDLEDDSANYP SNLEARYKG
 YLEGYEKGLKGDDIPERPKIQVPEDVQPSDHGDYRDGYEEGFGEGQHKRDPLETEAEDDSQGGRQEGRQGH
 QEGADSSDLNVEESDGLSVIDEVVGVIIYQAFSTIWTYLSGLF

SEQ ID NO: 79 polynucleotide sequence encoding GAS 58

ATGAAATGGAGTGGTTTTATGAAAACAAAATCAAACGCTTTTAAACCTAGCAACCCTTTGCTTGGCCCT
 ACTAGGAACAACCTTGCTAATGGCACATCCCGTACAGGCGGAGGTGATATCAAAAAGAGACTATATGACTC
 GCTTCGGGTTAGGCGATTTAGAAGATGATTCAGCTAACTATCCTTCAAATTTAGAAGCTAGATATAAAGGA
 TATTTAGAGGGATATGAAAAGGCTTAAAAGGAGATGATATACCCGAACGGCCCAAGATTCAGGTTCTGA
 GGATGTTTCAGCCATCTGACCATGGCGACTATAGAGATGGTTATGAGGAAGGATTTGGAGAAGGACAACATA
 AACGTGATCCATTAGAAACAGAAGCAGAAGATGATTCTCAAGGAGGACGTCAAGAAGGACGTCAAGGACAT
 CAAGAAGGAGCAGATTCTAGTGATTTGAACGTTGAAGAAAGCGACGGTTTGTCTGTTATTGATGAAGTAGT
 TGGAGTAATTTATCAAGCATTAGTACTATTTGGACATACTTAAGCGGTTTGTCTAA

SEQ ID NO: 80 amino acid sequence comprising N-terminal leader sequence of GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMA

SEQ ID NO: 81 amino acid sequence comprising a fragment of GAS 58 where the N-terminal leader sequence is removed

HPVQAEVISKRDYMTFRFGLGDLEDDSANYP SNLEARYKGYLEGYEKGLKGDDIPERPKIQVPEDVQPSDHG
 DYRDGYEEGFGEGQHKRDPLETEAEDDSQGGRQEGRQGHQEGADSSDLNVEESDGLSVIDEVVGVIIYQAFS
 TIWTYLSGLF

SEQ ID NO: 82 amino acid sequence comprising GAS 290

SEQUENCE LISTING

MKHILFIVGSLREGSFNHLAAQAQKALEHQAVVSYLNWKDVPVLNQDIEANAPLPVVDARQAVQSADAIW
 IFTPVYNFSIPGSVKNLLDWLSRALDLSDPTGPSAIGGKVTVSSVANGGHDQVFDQFKALLPFI RTSVAG
 EFTKATVNPDAWGTGRLEISKETKANLLSQAEALLAAI

SEQ ID NO: 83 polynucleotide sequence encoding GAS 290

ATGAAACATATTTTATTATTGTTGGCTCGCTTCGTGAAGGGTCTTTTAACCATCAATTAGCGGCTCAAGC
 ACAAAAAGCTCTGGAACATCAAGCAGTTGTATCTTACTTAAATTGGAAAGACGTTCTGTGTTTGAATCAAG
 ATATCGAAGCTAATGCACCTTTACCAGTTGTTGACGCTCGTCAAGCTGTTTCAGTCAGCGGATGCTATCTGG
 ATTTTACACCAAGTTTACAACCTTCTCTATTCCAGGTTCTGTTAAAAACCTGCTAGACTGGTTGTCTCGTGC
 TCTTGATTGTCTGATCCGACGGGCCCATCTGCTATTGGCGGTAAGGTGGTTACGGTCTCTTCAGTTGCAA
 ATGGCGGGCATGATCAAGTATTTGATCAGTTTAAAGCACTATTGCCGTTTATCCGAACCTTCAGTAGCAGGA
 GAGTTTACAAAAGCAACTGTGAATCCTGATGCCTGGGGAACAGGAAGGCTTGAGATTTCAAAGAGACAAA
 AGCAAACCTTGCTATCTCAGGCAGAGGCTCTTTTAGCGGCTATTTAG

SEQ ID NO: 84 amino acid sequence comprising GAS 511

MTDVSRLKEARDQGRLTTL DYANLIFDDFMELHGD RHFSDDGAIVGGLAYLAGQPVTVIGIQKGKNLQDN
 LARNFGQPNPEGYRKALRLMKQAEKFRPVVTFINTAGAYPGVGAEERGQGEAIAKNLMEMSDLKVPIIAI
 IIGEGSGGALALAVADQVWMLENTMYAVLSPEGFASILWKDGS RATEAAELMKITAGELYKMGIVDRIIP
 EHG YFSSEIVDIIKANLIEQITSLQAKPLDQLLDERYQRF RKY

SEQ ID NO: 85 polynucleotide sequence encoding GAS 511

ATGACAGATGTATCAAGAATTTTAAAGAAGCGCGTGATCAAGGGCGTTTAAACAACCTTTGGATTACGCCAA
 CCTTATTTTCGATGACTTTATGGAAGTGCATGGCGATCGCCATTTTTCAGATGATGGTGCCATTGTAGGTG
 GCCTAGCTTATTTGGCGGGACAACCTGTTACGGTCATTGGTATTCAAAAAGGTAAGAATTTACAGGATAAT
 TTGGCAAGGAATTTTGGCCAGCCCAATCCAGAAGGTTATCGTAAAGCTTTGCGCCTTATGAAACAGGCAGA
 AAAATTTGGACGACCAGTTGTTACGTTTATCAATACTGCAGGAGCCTATCCAGGTGTCCGTGCGGAAGAAC
 GAGGACAGGGTGAGGCCATTGCTAAAAATTTGATGGAAATGAGTGATCTCAAGGTTCCCATTTATCGCCATC
 ATTATTGGTGAAGGAGGCTCTGGTGGTGCATTAGCCTTAGCGGTTGCCGATCAGGTCTGGATGCTTGAAAA
 TACTATGTATGCGGTTCTTAGCCAGAAAGGCTTTGCTTCTATTTTATGGAAGGATGGTTCAAGGGCGACCG
 AGGCCGCTGAATTGATGAAAATCACAGCGGGTGAACCTTACAAAATGGGAATAGTAGACCGTATTATTCCA
 GAACATGGTTATTTTCAAGTGAAATCGTTGACATCATCAAAGCTAACCTCATCGAACAAATAACCAGTTT
 GCAAGCTAAGCCATTAGACCAATTATTAGATGAGCGCTACCAACGCTTTCGTAAATATTAA

SEQ ID NO: 86 amino acid sequence comprising GAS 533

MAITVADIRREVKEKNVTFRLRMFTDIMGVMKNVEIPATKEQLDKVLSNKVMFDGSSIEGFVRINESDMYL
 YPDLDTWIVFPWGDENGAVAGLICDIYTAEGKPFAGDPRGNLKRALKHMNEIGYKSFNLGPEPEFFLFKMD
 DKGNP TLEVNDNGGYFDLAPIDLADNTRREIVNILTKMGFEVEASHHEVAVGQHEIDFKYADVLKACDNIQ
 IFKL VVKTIAREHGLYATFMAKPKFGIAGSGMHCNMSLFDNQGNNAFYDEADKRGMLSEDAYYFLGGLMK
 HAYNYTAITNPTVNSYKRLVPGYEAPVYVAVAGSNRSPLIRVPASRGMGTRLELRSVDPTANPYLALAVLL
 EAGLDGIINKIEAPEPEANIYTMTMEERNEAGIIDLPSTLHNALKALQKDDVVQKALGYHIYTNFLEAKR
 IEWSSYATFVSQWEIDHYIHNY

SEQ ID NO: 87 polynucleotide sequence encoding GAS 533

ATGGCAATAACAGTAGCTGACATTCGTCTGTAAGTCAAAGAAAAAATGTAACGTTTCTTCGCTTGATGTT
 CACTGATATCATGGGCGTTATGAAAAATGTGGAGATTCTTGCAACTAAAGAACAGTTAGACAAAGTATTGT
 CTAACAAGGTTATGTTTGATGGTTCATCTATCGAAGGTTTGTACGGATCAATGAGTCAGATATGTACCTT
 TACCCCGATTTAGACACTTGGATTGTTTTTCCCTGGGGAGATGAAAATGGAGCAGTTGCAGGTTTAATTTG
 TGATATTTATACAGCAGAAGGAAAGCCTTTTGCAGGAGATCCTAGAGGAAATTTAAAAAGAGCCCTGAAAC
 ACATGAACGAGATCGGCTACAAATCATTTAATCTTGGACCAGAACCAGAATTTTTCCTTTTAAAGATGGAT
 GATAAAGGTAATCCGACACTTGAAGTTAACGATAATGGTGGTTATTTTGTATTAGCGCCAATTGACTTAGC
 AGACAACACGCGCCGTGAAATTGTGAATATTTTAACGAAAATGGGTTTTGAAGTGGAAGCTAGTCATCATG
 AAGTGGCTGTTGGTCAACATGAGATTGATTTTAAATATGCAGATGTTTTGAAAGCTTGTGATAATATTCAA
 ATTTTGAAGCTAGTTGTAAAAACGATTGCCCGTGAACATGGACTTTATGCTACTTTCATGGCTAAACCAA
 ATTTGGAATAGCTGGATCAGGGATGCACTGTAACATGCTTTTGTGTTGATAACCAAGGTAATAATGCTTTT
 ATGATGAAGCTGATAAGCGAGGGATGCAGTTATCAGAAGATGCTTATTATTTCTTGGGAGGACTAATGAAG
 CATGCTTATAACTACACTGCTATCACTAACCTACAGTGAATTCCTATAAACGATTAGTTCCAGGTTATGA

SEQUENCE LISTING

GGCACCTGTTTATGTCGCTTGGGCTGGAAGTAATCGTTCACCGCTTATCCGTGTTCCAGCATCACGTGGTA
 TGGGAACGCGTTTGGAGTTACGTTCCGGTTGATCCGACAGCTAATCCTTATTTAGCCTTGGCTGTTCTCTTG
 GAAGCTGGATTAGATGGTATCATTAACAAAATTGAAGCTCCAGAACCCGTTGAAGCTAACATTTATACCAT
 GACAATGGAAGAACGAAATGAAGCAGGCATTATTGATTTGCCATCAACGCTTCATAATGCCTTAAAAGCTC
 TTCAAAAAGATGATGTGGTACAAAAGGCACCTAGGTTACCATATCTACACTAATTTCTTAGAAGCAAAACGA
 ATTGAATGGTCTTCTATGCAACTTTTGTCTCAATGGGAAATTGACCATTATATTCATAATTATTAG

SEQ ID NO: 88 amino acid sequence comprising GAS 527

MTEISILNDVQKIIVLDYGSQYNQLIARRIREFGVFSSELKSHKITAQELREINPIGIVLSGGPNSVYADNA
 FGIDPEIFELGIPILGICYGMLITHKLGGKVVPAGQAGNREYQSTLHLRETSKLFSGTPQEQLVLMESHG
 DAVTEIPEGFHLVGDSNDPCYAAIENTEKNLYGIQFHPVRHSVYGNLILKNFAISICGARGDWSMDNFID
 MEIAKIRETVGDRKVLGLSGGVDSSVGVLLQKAIGDQLTCIFVDHGLLRKDEGDQVMGMLGGKFGNLII
 RVDASKRFLDLLADVEDPEKKRKIIIGNEFVYVFDDEASKLKGVDFLAQGTLYTDIIESGTETAQTIKSHHN
 VGGLPEDMQFELIEPLNTLFKDEVRLGIALGMPEEIVWRQFPFPGPLAIRVMGAITEEKLETVRESDAIL
 REEIAKAGLDRDVWQYFTVNTGVRVSGVMGDGRTYDYTIAIRAITSIDGMTADFAQLPWDVLKKISTRIVN
 EVDHVNRIYDITSKPPATVEWE

SEQ ID NO: 89 polynucleotide sequence encoding GAS 527

ATGACTGAAATTTCAATTTTGAATGATGTTCAAAAAATTATCGTTCCTTGATTATGGTAGCCAGTACAATCA
 GCTTATTGCTAGACGTATTCGAGAGTTTGGTGTCTTCTCCGAACATAAAAGCCATAAAATCACCGCTCAAG
 AACTTCGTGAGATCAATCCCATAGGTATCGTTTTATCAGGAGGGCCTAACTCTGTTTACGCTGATAACGCC
 TTTGGCATTGACCCTGAAATCTTTGAAGTAGGGATTCCGATTCTTGGTATCTGTTACGGTATGCAATTAAT
 CACCCATAAATTAGGTGGTAAAGTTGTTCTTGCTGGACAAGCTGGTAATCGTGAATACGGTCAGTCAACCC
 TTCATCTTCGTGAAACGTCAAATTTATTTTCAGGCACACCTCAAGAACAACTCGTTTTGATGAGCCATGGT
 GATGCTGTTACTGAAATTCAGAAAGGTTTCCACCTTGTGGAGACTCAAATGACTGTCCCTATGCAGCTAT
 TGAAATACTGAGAAAAACCTTTACGGTATTGAGTTCCACCCAGAAAGTGAGACACTCTGTTTATGGAAATG
 ACATTCTTAAAACTTTGCTATATCAATTTGTGGCGCGCGTGGTGATTGGTCAATGGATAATTTTATTGAC
 ATGGAAATTGCTAAATTCGTGAAACTGTAGGCGATCGTAAAGTTCTTCTAGGTCTTTCTGGTGGAGTTGA
 TTCTTCAGTTGTTGGTGTCTACTTCAAAAAGCTATCGGTGACCAATTAACCTGTATTTTCGTTGATCAGG
 GTCTTCTTCGTAAAGACGAGGGCGATCAAGTTATGGGAATGCTTGGGGGCAAAATTTGGCCTAAATATTATC
 CGTGTGGATGCTTCAAAACGTTTCTTAGACCTTCTTGCAGACGTTGAAGATCCTGAGAAAAACGTAAAT
 TATTGGTAATGAATTTGTCTATGTTTTTGATGATGAAGCCAGCAAATTAAGAGGTGTTGACTTCCTTGCCC
 AAGGAACACTTTATACTGATATCATTGAGTCAGGAACAGAACTGCTCAAACCATCAAATCACATCACAAT
 GTGGGTGGTCTCCCGAAGACATGCAGTTTGAATTGATTGAGCCCTTAAACACTCTTTTCAAAGATGAAGT
 TCGAGCGCTTGGAAATCGCTCTTGGAAATGCCTGAAGAAATTGTTTGGCGCCAACCATTTCCAGGTCTTGAC
 TTGCTATCCGTGTATGGGAGCAATTACTGAAGAAAACTTGAAACCGTTCGCGAATCAGACGCTATCCTT
 CGTGAAGAAATTGCTAAGGCTGGACTTGATCGTGACGTGTGGCAATACTTTACAGTTAACACAGGTGTCCG
 TTCTGTAGGCGTCATGGGAGATGGTCGTACTTATGATTATACCATCGCCATTCGTGCTATTACGTCTATTG
 ATGGTATGACAGCTGACTTTGCTCAACTTCCTTGGGATGTCTTGAAAAAATCTCAACACGTATCGTAAAT
 GAAGTTGACCACGTTAACCGTATCGTCTACGACATCACAAGTAAACCACCCGCAACAGTTGAATGGGAATA
 A

SEQ ID NO: 90 amino acid sequence comprising GAS 294

MSQSTATYINVIGAGLAGSEAAYQIAKRGIPVKLYEMRGVKATPQHKTTFNFAELVCSNSFRGDSLTVNAVGL
 LKEEMRRLLDSIIMRNGEANRVPAGGAMAVDREGYAESVTAELNHLPIEVIRGEITEIPDDAITVIATGPL
 TSDALAEKIHALLNGGDGFYFYDAAPIIDKSTIDMSKVYLKSRDYGKGEAYLNCNCPMTKEEFMAFHEALTTA
 EEAPLNAFEKEKYFEGCMPPIEVMAKRGIKTMLYGPMKPVGLEYPDDYTGPDRDGEFKTPYAVVQLRQDNAAG
 SLYNIVGFQTHLKWGEQKRVFQMI PGLNNAEFVRYGVMHRNSYMDSPNLLTETFQSRSPNLPFFAGQMTGV
 EGYVESAAAGLVAGINAARLFKREELIFPQTTAIGSLPHYVTHADSKHFQPMNVNFGI I KELEGPRIRDK
 KERYEAIASRALADLDTCLASL

SEQ ID NO: 91 polynucleotide sequence encoding GAS 294

TTGTCTCAATCAACTGCAACTTATATTAATGTTATTGGAGCTGGGCTAGCTGGTCTGAAGCTGCCTATCA
 GATTGCTAAGCGCGGTATCCCCGTTAAATTGTATGAAATGCGTGGTGTCAAAGCAACACCGCAACATAAAA
 CCACTAATTTTGCCGAATTGGTCTGTTCCAACCTCATTTCGTGGTGATAGCTTAACCAATGCAGTCGGTCTT
 CTCAAAGAAGAAATGCGGCGATTAGACTCCATTATTATGCGTAATGGTGAAGCTAACCGCGTACCTGCTGG

SEQUENCE LISTING

GGGAGCAATGGCTGTTGACCGTGAGGGGTATGCAGAGAGTGTCACTGCAGAGTTGGAAAATCATCCTCTCA
 TTGAGGTCATTTCGTGGTGAAATTACAGAAATCCCTGACGATGCTATCACGGTTATCGCGACGGGACCGCTG
 ACTTCGGATGCCCTGGCAGAAAAAATTCACGCGCTAAATGGTGGCGACGGATTCTATTTTTACGATGCAGC
 AGCGCCTATCATTGATAAATCTACCATTGATATGAGCAAGGTTTACCTTAAATCTCGCTACGATAAAGGCG
 AAGCTGCTTACCTCAACTGCCCTATGACCAAAGAAGAATTCATGGCTTTCCATGAAGCTCTGACAACCGCA
 GAAGAAGCCCCGCTGAATGCCCTTTGAAAAAGAAAAGTATTTTGAAGGCTGTATGCCGATTGAAGTTATGGC
 TAAACGTGGCATTAAACCATGCTTTATGGACCTATGAAACCCGTTGGATTGGAATATCCAGATGACTATA
 CAGGTCCTCGCGATGGAGAATTTAAACGCCATATGCCGTCGTGCAATTGCGTCAAGATAATGCAGCTGGA
 AGCCTTTATAATATCGTTGGTTTCCAAACCCATCTCAAATGGGGTGAGCAAAAACGCGTTTCCAAATGAT
 TCCAGGGCTTGAAAATGCTGAGTTTGTCCGCTACGGCGTCATGCATCGCAATTCCTATATGGATTACCAA
 ATCTTTTAACCGAAACCTTCCAATCTCGGAGCAATCCAAACCTTTTCTTTGCAGGTCAGATGACTGGAGTT
 GAAGGTTATGTCGAATCAGCTGCTTCAGGTTTAGTAGCAGGAATCAATGCTGCTCGTTTGTTCAAAAGAGA
 AGAAGCACTTATTTTCTCAGACAACAGCTATTGGGAGTTTGCCTCATTATGTGACTCATGCCGACAGTA
 AGCATTTCCAACCAATGAACGTCAACTTTGGCATCATCAAAGAGTTAGAAGGCCACGCATTCGTGACAAA
 AAAGAACGTTATGAAGCTATTGCTAGTCGTGCTTTGGCAGATTTAGACACCTGCTTAGCGTCGCTTTAA

SEQ ID NO: 92 amino acid sequence comprising GAS 253

MPKKILFTGGGTVGHVTLNLILIPKFIKDGWEVHYIGDKNGIEHTEIEKSLDVTFHAIATGKLRRYFSWQ
 NLADVFKVALGLLQSLFIVAKLRPQALFSKGGFVSVPPVVAAKLLGKPVFIHESDRSMGLANKIAYKFATT
 MYTTFEQEDQLSKVKHLGAVTKVFKDANQMPESTQLEAVKEYFSRDLKTLFFIGGSAGAHVFNQFISDHPE
 LKQRYNIINITGDPHLNELSSHLRYVDYVTDLYQPLMAMADLVVTRGGSNTLFE LLAMAKLHLIVPLGKEA
 SRGDQLENATYFEKRGYAKQLQEPDLTLHNFDQAMADLFEHQADYEATMLATKEIQSPDFFYDLLRADISS
 AIKEK

SEQ ID NO: 93 polynucleotide sequence encoding GAS 253

ATGCCTAAGAAGATTTTATTTACAGGTGGTGGAACTGTAGGTCATGTCACCTTGAACCTCATTCTCATACC
 AAAATTTATCAAGGACGGTTGGGAAGTACATTATATTGGTGATAAAAATGGCATTGAACATACAGAAATTG
 AAAAGTCAGGCCTTGACGTGACCTTTCATGCTATCGCGACAGGCAAGCTTAGACGCTATTTTTCATGGCAA
 AATCTAGCTGATGTTTTTAAGGTTGCACTTGGCCTCCTACAGTCTCTCTTTATTGTTGCCAAGCTTCGCCC
 TCAAGCCCTTTTTTCCAAAGGTGGTTTTGTCTCAGTACCGCCAGTTGTGGCTGCTAAATTGCTTGGTAAAC
 CAGTCTTTATTATCATGAATCAGATCGGTCAATGGGACTAGCAAACAAGATTGCCTACAAATTTGCAACTACC
 ATGTATACCACTTTTGAGCAGGAAGACCAGTTGTCTAAAGTTAAACACCTTGGAGCGGTGACAAAGGTTTT
 CAAAGATGCCAACCAAAATGCCTGAATCAACTCAGTTAGAGGCGGTGAAAGAGTATTTTAGTAGAGACCTAA
 AAACCTCTTGTTTATTGGTGGTTCGGCAGGGGCGCATGTGTTTAATCAGTTTATTAGTGATCATCCAGAA
 TTGAAGCAACGTTATAATATCATCAATATTACAGGAGACCCTCACCTTAATGAATTGAGTTCATCTGTA
 TCGAGTAGATTATGTTACCGATCTCTACCAACCTTTGATGGCGATGGCTGACCTTGTAGTGACAAGAGGGG
 GCTCTAATACACTTTTTGAGCTACTGGCAATGGCTAAGCTACACCTCATCGTTCCTCTTGGTAAAGAAGCT
 AGCCGTGGCGATCAGTTAGAAAATGCCACTTATTTTGAGAAGAGGGGCTACGCTAAACAATTACAGGAACC
 TGATTTAACTTTGCATAATTTTGATCAGGCAATGGCTGATTTGTTTGAACATCAGGCTGATTATGAGGCTA
 CTATGTTGGCAACTAAGGAGATTCAGTCACCGGACTTCTTTTATGACCTTTTGAGAGCTGATATTAGCTCC
 GCGATTAAGGAGAAGTAA

SEQ ID NO: 94 amino acid sequence comprising GAS 529

MCGIVGVGNRNATDILMQGLEKLEYRGYDSAGIFVANANQTNLIKSVGRIADLRKIGIDVAGSTGIGHT
 RWATHGQSTEDNAHPHTSQTGRFVLVHNGVIENYLHIKTEFLAGHDFKGQTDTEIAVHLIGKFVEEDKLSV
 LEAFKKSLSIIEGSYAFALMDSQATDTIYVAKNKSPLLIGLGEYNMVCSDAMAMIRETSEFMEIHDKELV
 ILTKDKVTVDYDGKELIRDSYTAELDLSDIGKGYPFYMLKEIDEQPTVMRQLISTYADETG NVQVDP AI
 ITS IQEADR LYILAAGTSYHAGFATKNMLEQLTDPVELGVASEWGYHMP LLSKKPMFILL SQSGETADSR
 QVLVKANAMGIPSLTVTNVPGSTLSREATYTMLIHAGPEIAVASTKAYTAQIAALAFLAKAVGEANGKQEA
 LDFNLVHEL SLVAQSI EATLSEKDLVAEKVQALLATTRNAFYIGRGN DYVAMEAALKLKEISYIQCEGFA
 AGELKHGTISLIEEDTPVIALISSSQLVASHTRGNIQEVAARGAHVLT VVEEGLDREGDDI IVNKVHPFLA
 PIAMVIPTQLIAYYASLQRLDVKPRNLAKAVTVE

SEQ ID NO: 95 polynucleotide sequence encoding GAS 529

ATGTGTGGAATTGTTGGAGTTGTTGGAAATCGCAATGCAACGGATATTTTAAATGCAAGGCCTTGAAAAGCT
 TGAATACCGGGGTTATGATTCAGCAGGAATTTTGTGGCTAATGCCAATCAAACAACTTGATTAAATCAG

SEQUENCE LISTING

TGGGGCGGATTGCTGATTTGCGTGCCAAGATTGGCATTGATGTTGCTGGTTCAACAGGGATTGGTCACACC
 CGTTGGGCAACGCATGGCCAATCAACAGAGGATAATGCCCATCCTCACACGTCACAACTGGACGTTTTGT
 ACTTGTTTCATAATGGTGTGATTGAAAATTACCTTCACATTAAAACAGAGTTCCTAGCTGGACATGATTTTA
 AGGGGCAGACAGATACTGAGATTGCAGTACACTTGATTGGAAAATTTGTGGAAGAAGACAAGTTGTCAGTA
 CTGGAAGCTTTTAAAAAATCTTTAAGCATTATTGAAGGTTCTACGCCTTTGCATTAATGGATAGCCAAGC
 AACTGATACTATTTATGTGGCTAAAAACAAGTCTCCATTGTTGATTGGACTTGGTGAAGGTTACAACATGG
 TTTGTTTCAGATGCCATGGCCATGATTCGTGAAACCAGTGAATTTATGGAAATTCATGATAAGGAGCTAGTT
 ATTTTAACCAAAGATAAGGTAACGTGTTACAGACTACGATGGTAAAGAGCTGATACGAGATTCCTACACTGC
 TGAATTAGACTTATCTGATATTGGCAAAGGGACTTATCCTTTCTATATGCTGAAAGAAATTGATGAGCAAC
 CAACCGTAATGCGTCAATTAATTTCAACTTATGCAGATGAAACTGGTAACGTACAGGTTGATCCGGCTATC
 ATTACCTCTATCCAAGAGGCTGACCGTCTTTATATTTTAGCGGCAGGGACTTCCTACCATGCTGGTTTTGC
 AACAAAAAATATGCTTGAGCAATTGACAGATACACCAGTTGAGTTGGGCGTGGCTTCTGAGTGGGGTTACC
 ACATGCCTCTGCTTAGCAAGAAACCAATGTTTATTCTACTAAGCCAATCAGGAGAAACCGCAGATAGTCGT
 CAAGTTTATAGTAAAGGCAAATGCTATGGGCATTCCGAGTTTGACAGTAACTAACGTTCCAGGATCAACCTT
 ATCACGTGAAGCAACATACACCATGTTGATTTCATGCTGGACCTGAAATTGCTGTTGCGTCTACAAAAGCTT
 ACACTGCACAAATTGCTGCCCTTGCCCTTTTTGGCTAAGGCAGTTGGTGAGGCAAATGGTAAGCAAGAAGCT
 CTTGACTTTAACTTGGTACATGAGTTGTCATTGGTTGCCCAATCTATTGAGGCGACTTTGTCTGAAAAAGA
 TCTCGTGGCAGAAAAGGTTCAAGCTTTGCTAGCTACTACTCGTAATGCTTTTTTACATCGGGCGTGGCAATG
 ATTATTACGTTGCGATGGAAGCTGCTTTGAAATTAAAAGAGATTTCTTATATTCAATGCGAAGGCTTTGCG
 GCTGGTGAATTGAAACATGGAACCATTTTCAATTAATTGAGGAGGACACGCCAGTAATCGCTTTAATATCGTC
 TAGTCAGTTGGTTGCCCTCTCATACGCGTGGTAATATTCAAGAAGTTGCTGCCCGTGGGGCTCATGTTTTAA
 CAGTTGTGGAAGAAGGGCTTGACCGTGAGGGAGATGACATTATTGTCAATAAGGTTTCATCCTTTCCTAGCC
 CCGATTGCTATGGTCATTCCAACCTCAACTGATTGCTTACTACGCTTCATTACAACGTGGACTTGATGTTGA
 TAAGCCACGTAATTTGGCTAAAGCTGTAACAGTAGAATAA

SEQ ID NO: 96 amino acid sequence comprising GAS 45

VTFMKKSKWLAASVAILSVSALAACGNKNASGGSEATKTYKYVFNPKSLDYILTNGGGTTDVITQMVD
 GLENDEYGNLVP SLAKDWKVS KDGLTYTYTLRDGVSWYTADGEEYAPVTAEDFVTGLKHAVDDKSDALYV
 VEDSIKNL KAYQNGEVDFKEVGVKALDDKT VQYTLNKPESYWN SKTYSVLFPVNAKFLKSKGKDFGTTDP
 SSILVNGAYFLSAFTSKSSMEFHKNENYWDAKNVGIESVKLTYS DGS DPGSFYKNFDKGEFSVARLYPNDP
 TYKSAKNYADNITYGMLTGDIRHLTNWLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQA
 QTAGQDAKTALRNMLVPPTFVTIGESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKE
 ALTAEGVTFFVQLDYPVDQANAATVQEAQSFKQSVEASLGKENVIVNVLETETSTHEAQGFYAETPEQQDY
 DIISSWGPDYQDPRTYLDIMSPVGGG SVIQKLGIKAGQNKDVVAAAGLDTYQTLLEAAAITDDNDARYK
 AYAKAQAYLTDNAVDI PVVALGGTPRVTKAVPFSGGFSWAGSKGPLAYKGMKLQDKPVTVKQYEKAKEKWM
 KAKAKSNAKYAEKLADHVEK

SEQ ID NO: 97 polynucleotide sequence encoding GAS 45

GTGACTTTTATGAAGAAAAGTAAATGGTTGGCAGCTGTAAGTGTTGCGATCTTGTCAGTATCCGCTTTGGC
 AGCTTGTGGTAATAAAAATGCTTCAGGTGGCTCAGAAGCTACAAAAACCTACAAGTACGTTTTTGTAAACG
 ATCCAAAATCATTGGATTATATTTTACTAATGGCGGTGGAACGACTGATGTGATAACACAAATGGTTGAT
 GGTCTTTTGGAAAACGATGAGTATGGTAATTTAGTACCATCACTTGCTAAAGATTGGAAGGTTTCAAAAGA
 CGGTCTGACTTATACTTATACTCTTCGCGATGGTGTCTCTTGGTATACGGCTGATGGTGAAGAATATGCCC
 CAGTAACAGCAGAAGATTTTGTGACTGGTTTGAAGCACGCGGTTGACGATAAATCAGATGCTCTTTACGTT
 GTTGAAGATTCAATAAAAAACTTAAAGGCTTACCAAAATGGTGAAGTAGATTTTAAAGAAGTTGGTGTCAA
 AGCCCTTGACGATAAACTGTTTCAGTATACTTTGAACAAGCCTGAAAGCTACTGGAATTCAAAACAACCTT
 ATAGTGTGCTTTTCCCAGTTAATGCGAAATTTTGAAGTCAAAGGTAAGATTTTGGTACAACCGATCCA
 TCATCAATCCTTGTTAATGGTGTCTTCTTGTGAGCGCCTTCACCTCAAATCATCTATGGAATTCATAA
 AAATGAAAAC TACTGGGATGCTAAGAATGTTGGGATAGAATCTGTTAAATTGACTTACTCAGATGGTTTCA
 ACCAGGTTTCGTTCTACAAGAACTTTGACAAGGGTGAGTTCAGCGTTGCACGACTTTACCCAAATGACCTT
 ACCTACAAATCAGCTAAGAAAACTATGCTGATAACATTACTTACGGAATGTTGACTGGAGATATCCGTCA
 TTTAACATGGAATTTGAACCGTACTTCTTTCAAAAACACTAAGAAAGACCCTGCACAACAAGATGCCGGTA
 AGAAAGCTCTTAACAACAAGGATTTTCGTCAAGCTATTTCAGTTTGCTTTTGACCGAGCGTCATTCCAAGCA
 CAACTGCAGGTCAAGATGCCAAAACAAAAGCCTTACGTAACATGCTTGTCCCAACACATTTGTGACCAT
 TGGAGAAAGTGATTTTGGTTT CAGAAGTTGAAAAGGAAATGGCAAACTTGGTGATGAATGGAAAGACGTTA
 ACTTAGCTGATGCTCAAGATGGTTTCTATAATCCTGAAAAAGCAAAGCTGAGTTTGCAAAGCCAAAGAA

SEQUENCE LISTING

GCTTTAACAGCTGAAGGTGTAACCTTCCCAGTTCAATTAGATTACCCTGTTGACCAAGCAAACGCAGCAAC
 TGTTTCAGGAAGCCCAGTCTTTCAAACAATCTGTTGAAGCATCTCTTGGTAAAGAGAATGTCATTGTCAATG
 TTCTTGAAACAGAAACATCAACTCACGAAGCCCAAGGCTTCTATGCTGAGACCCCAGAACAACAAGACTAC
 GATATCATTTCATCATGGTGGGGACCAGACTATCAAGATCCACGGACCTACCTTGACATCATGAGTCCAGT
 AGGTGGTGGATCTGTTATCCAAAACTTGGAATCAAAGCAGGTCAAATAAGGATGTTGTGGCAGCTGCAG
 GCCTTGATACCTACCAAACTCTTCTTGATGAAGCAGCAGCAATTACAGACGACAACGATGCGCGCTATAAA
 GCTTACGCAAAAGCACAGCCTACCTTACAGATAATGCCGTAGATATTCCAGTTGTGGCATTGGGTGGCAC
 TCCACGAGTTACTAAAGCCGTTCCATTTAGCGGGGGCTTCTCTTGGGCAGGGTCTAAAGGTCCTCTAGCAT
 ATAAAGGAATGAACTTCAAGACAAACCTGTACAGTAAACAATACGAAAAGCAAAAGAAAAATGGATG
 AAAGCAAAGGCTAAGTCAAATGCAAAATATGCTGAGAAGTTAGCTGATCACGTTGAAAAA

SEQ ID NO: 98 amino acid sequence comprising an N-terminal leader sequence of GAS 45
 VTFMKKSKWLAAVSVAILSVSALAA

SEQ ID NO: 99 amino acid sequence comprising a fragment of GAS 45 where the N-terminal
 leader sequence is removed

CGKNASGGSEATKTYKYVFNPKSLDYILTNGGGTTDVITQMVDGLENDEYGNLVP SLAKDWKVS KDG
 LTYTYTLRDGVSWYTADGEEYAPVTAEDFVTGLKHAVDDKSDALYVVEDSIKNL KAYQNGEVDFKEVGVKA
 LDDKT VQYTLNKPESYWNSKTTYSVLFPVNAKFLKSKGKDFGTTDPSSILVNGAYFLSAFTSKSSMEFHKN
 ENYWD AKNVGIESVKLTYSDGSDPGSFYKNFDKGEFSVARLYPNPTYKSAKKNYADNITYGMLTGDIRHL
 TWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRASFQAQTAGQDAKTKALRNMLVPPTFVTIG
 ESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKEALTAEGVTFPVQLDYPVDQANAATV
 QEAQSFKQSVEASLGKENVIVNVLETETSTHEAQGFYAETPEQQDYDIISWWGPDYQDPRTYLDIMSPVG
 GGSVIQKLGIKAGQNKDVVAAAGLDTYQTLLEDEAAITDDNDARYKAYAKAQAYLTDNAVDIPVVALGGTP
 RVTKAVPFSGGFSWAGSKGPLAYKGMKLQDKPVTVKQYEKAKEKWMKAKAKSNAKYAEKLADHVEK

SEQ ID NO: 100 amino acid sequence comprising GAS 95

MKIGKKIVLMFTAIVLTTVLALGVYLT SAYTFSTGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGS
 SERASKWEGNSDSMILVTVPNPKTKKTTMTSLERDTLTTL SGPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQ
 DLLNITIDNYVQINMQGLIDL VNAVGGITVTNEFD FPI SIAENEPEYQATVAPGTHKINGEQALVYARMRY
 DDPEGDYGRQKRQREVIQKVLKKILALDSISSYRKILSAVSSNMQTNIEISSRTIPSL LGYRDALRTIKTY
 QLKGEDATLSDGGSYQIVTSNHLLEIQNRIRTELGLHKVNQLKTNATVYENLYGSTKSTQTVNNNYDSSGQA
 PSYSDSHSSYANYSSGVDTGQSASTDQDSTASSHRPATPSSSSDALAADESSSSSGSGSLVPPANINPQT

SEQ ID NO: 101 polynucleotide sequence encoding GAS 95

ATGAAAATTGGAATAAATAGTTTTAATGTTCAAGCTATTGTGTTAACAAGTCTTGGCATTAGGTGT
 CTATCTAACTAGTGCTTATACCTTCTCAACAGGAGAATTATCAAAGACCTTTAAAGATTTTTCGACATCTT
 CAAACAAAAGTGATGCCATTAAACAAACAAGAGCTTTTCTATCTTGTGATGGGTGTTGATACAGGCTCT
 TCAGAGCGTGCTCCAAGTGGGAAGGAAACAGTGATTCGATGATTTTGGTTACGGTTAATCCAAAGACCAA
 GAAACAACATATGACTAGTTTAGAACGAGATACCTTAACCACGTTATCTGGACCCAAAATAATGAAATGA
 ATGGTGTGTAAGCTAAGCTTAACGCTGCTTATGCAGCAGGTGGCGCTCAGATGGCTATTATGACCGTGCAA
 GATCTTTTGAATATCACCATTGATAACTATGTTCAAATTAATATGCAAGGCCTTATTGATCTTGTGAATGC
 AGTTGGAGGGATTACAGTTACAAATGAGTTTGATTTTCCTATCTCGATTGCTGAAAACGAACCTGAATATC
 AAGCTACTGTTGCGCCTGGAACACACAAAATTAACGGTGAACAAGCTTTGGTTTATGCTCGTATGCGTTAT
 GATGATCCTGAGGGAGATTATGGTCGACAAAAGCGTCAACGTGAAGTCATTCAAAGGTATTGAAAAAAT
 CCTTGCTCTTGATAGCATTAGCTCTTATCGGAAGATTTTATCTGCTGTAAGTAGTAATATGCAAACGAATA
 TCGAAATCTCTTCTCGCACTATCCCTAGTCTATTAGGTTATCGTGACGCACTTAGAACTATTAAGACTTAT
 CAACTAAAAGGAGAAGATGCCACTTTATCAGATGGTGGATCATAACCAATTGTTACCTCTAATCATTGTGTT
 AGAAATCCAAAATCGTATCCGAACAGAATTAGGACTTCATAAGGTTAATCAATTAAAAACAAATGCTACTG
 TTTATGAAAATTTGTATGGGTCAACTAAGTCTCAGACAGTAAACAACAATATGACTCTTCAGGCCAGGCT
 CCATCTTATTCTGATAGTCATAGCTCTTACGCTAATTATTCAAGTGGAGTAGATACCGGCCAGAGTGCTAG
 TACAGACCAGGACTCTACTGCTTCAAGCCATAGGCCAGCTACGCCGTCTTCTTCATCAGATGCTTTAGCAG
 CTGATGAGTCTAGCTCATCAGGGTCTGGATCATTAGTTCCTCCTGCTAATATCAACCCTCAGACCTAA

SEQ ID NO: 102 amino acid sequence comprising N-terminal leader sequence of GAS 95
 MKIGKKIVLMFTAIVLTTVLALGVYLT SAYTFS

SEQUENCE LISTING

SEQ ID NO: 103 amino acid sequence comprising a fragment of GAS 95 where the N-terminal leader sequence is removed.

TGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGSSERASKWEGNSDSMILVTNPKTKKTTMTSLER
DTLTTLSPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQDLLNITIDNYVQINMQGLIDLVAVGGITVTNE
PDPPIAIAENEPEYQATVAPGTHKINGEQALVYARMRYDDPEGDYGRQKRQREVIQVLKKILALDSISSY
RKILSAVSSNMQTNIEISSRTIPSLGYPDALRTIKTYQLKGEDATLSDGGSYQIVTSNHLLEIQNRIRTE
LGLHKVNQLKTNATVYENLYGSTKSQTVNNNYDSSGQAPSYSDSHSSYANYSSGVDTGQSASTDQDSTASS
HRPATPSSSSDALAADESSSSSGSGLVPPANINPQT

SEQ ID NO: 104 amino acid sequence comprising GAS 193

MKKRKLLAVTLLSTILLNSAVPLVADTSLRNSTSSDQPTTADTDTTDESETPKKDKKSKETASQHDTQK
DHKPSHTHTPTPPSNDTKQTDQASSEATDKPNKDKNDTKQPDSSDQSTPSPKDQSSQKESQNKDGRPTPSPD
QQKDQTPDKTPEKSADKTPEKGPEKATDKTPEPNRDAPKPIQPPLAAAPVFI PWRESKDLSKLKPSRSS
AAYVRHWTGDSAYTHNLLSRRYGITAEQLDGFLNSLGIHYDKERLNGKRLLLEWEKLTGLDVRAIVAIAMAE
SSLGTQGVAKEKGANMFGYGAFFDNPNNAKKYSDEVAIRHMVEDTIIANKNQTFRQDLKAKKWSLGQLDT
LIDGGVYFTDTSGSGQRRADIMTKLDQWIDDHGSTPEIPEHLKITSQTGFSEVPVGYKRSQPQNVLTYSKSE
TYSFGQCTWYAYNRVKELGYQVDYRMNGGDWQRKPGFVTTHKPKVGYVVSFAPGQAGADATYGHVAVVEQ
IKEDGSILISESNMGLGTISYRTFTAQASLLTYVVGDKLPRP

SEQ ID NO: 105 polynucleotide sequence encoding GAS 193

ATGAAGAAAAGGAAATTGTTAGCAGTAACACTATTAAGTACCATACTCTTAAACAGTGCAGTGCCATTAGT
TGTTGCTGATACCTCCTTGCGTAATAGCACATCATCCACTGATCAGCCTACTACAGCAGATACTGATACGG
ATGACGAGAGTGAAACACCAAAAAAAGACAAAAAAGCAAGGAAACAGCGTCGCAGCACGACACCCAAAAA
GACCATAAGCCATCACACACTCACCCAACCCCCCTTCAAATGATACTAAGCAGACCGATCAGGCATCATC
TGAAGCTACTGACAAACCAAATAAAGACAAAAACGACACCAAGCAACCAGACAGCAGTGATCAATCCACCC
CATCTCCCAAAGACCAGTCGTCCTCAAAAAGAGTCACAAAACAAAGACGGCCGACCTACCCCATCACCTGAT
CAGCAAAAAGATCAGACACCTGATAAAACACCAGAAAAATCAGCTGATAAAACCCCTGAAAAAGGACCAGA
AAAAGCAACTGATAAAACACCAGAGCCAAATCGTGACGCTCCAAAACCCATCCAACCTCCTTTAGCAGCTG
CTCCTGTCTTTTATACCTTGAGAGAGAAAGTGACAAAGACCTGAGCAAGCTAAAACCAAGCAGTCGCTCATCA
GCGGCTTACGTGAGACACTGGACAGGTGACTCTGCCTACACTCACAACCTGTTGTCACGCCGTTATGGGAT
TACTGCTGAACAGCTAGATGGTTTTTTTGAACAGTCTAGGTATTCACATATGATAAAGAACGCTTAAACGGAA
AGCGTTTTATTAGAATGGGAAAAACTAACAGGACTAGACGTTTCGAGCTATCGTAGCTATTGCAATGGCAGAA
AGCTCACTAGGTACTCAGGGAGTTGCTAAAGAAAAAGGAGCCAATATGTTTGGTTATGGCGCCTTTGACTT
CAACCCAAACAATGCCAAAAAATACAGCGATGAGGTTGCTATTCGTACATGGTAGAAGACACCATCATTTG
CCAACAAAAACCAACCTTTGAAAGACAAGACCTCAAAGCAAAAAAATGGTCACTAGGCCAGTTGGATACC
TTGATTGATGGTGGGGTTTACTTTACAGATACAAGTGGCAGTGGGCAAGACGAGCAGATATCATGACCAA
ACTAGACCAATGGATAGATGATCATGGAAGCACACCTGAGATTCCAGAACATCTCAAGATAACTTCCGGGA
CACAATTTAGCGAAGTGCCCGTAGGTTATAAAAGAAGTCAGCCACAAAACGTTTTGACCTACAAGTCAGAG
ACCTACAGCTTTGGCCAATGCACCTGGTACGCCATATAATCGTGTCAAAGAGCTAGGTATCAAGTCGACAG
GTACATGGGTAACGGTGGCGACTGGCAGCGCAAGCCAGGTTTTGTGACCACCCATAAACCTAAAGTGGGCT
ATGTCGTCTCATTTCACACAGGCCAAGCAGGAGCAGATGCAACCTATGGTCACGTTGCTGTTGTAGAGCAA
ATCAAAGAAGATGGTTCCTATCTTAATTTACAGAGTCAAATGTTATGGGACTAGGCACCATTTCTATCGGAC
GTTACAGCTGAGCAGGCTAGTTTGTGACCTATGTCGTAGGGGACAACTCCCAAGACCATAA

SEQ ID NO: 106 amino acid sequence comprising GAS 137

MSDKHINLVIVTGMMSGAGKTVAIQSFEDLGYFTIDNMPPALVPKFLELIEQTNENRRVALVVDMRSLFFK
EINSTLDSIESNPSIDFRILFLDATDGELVSRYKETRRSHPLAADGRVLDGIRLERELLSPLKSMSQHVVD
TTKLTPRQLRKTISDQFSEGSNQASFRIEVMFSGFKYGLPLDADLVFDVRFNPYPYQVELREKTGLDEDV
FNYVMSPHPESEVFYKHLNLIVPILPAYQKEGKSVLTVAIGCTGGQHRVSFAHCLAESLATDWSVNESHR
DQNRKRVNRS

SEQ ID NO: 107 polynucleotide sequence encoding GAS 137

ATGTCAGACAAACACATTAATTTAGTTATTGTGACAGGAATGAGCGGCGCTGGAAAAACAGTTGCCATTCA
GTCTTTTGGAGGATCTAGGCTACTTTACCATTTGATAATATGCCCCCAGCCTTGGTTCCAAAATTTTGAAT
TAATTGAACAAACCAATGAAAATCGTAGGGTGGCTTTGGTTGTGATATGAGAAGTCGTTTGTTCATCAAG

SEQUENCE LISTING

GAAATTAATTCTACCTTAGATAGTATTGAAAGCAATCCTAGCATTGATTTTCGGATTCTTTTTTTGGATGC
AACGGATGGAGAATTGGTGTACGCTATAAAGAAACCAGACGGAGCCACCCTTTGGCTGCGGACGGTCGTG
TGCTTGATGGTATTCGATTGGAAAGAGAACTCCTATCTCCTTTGAAAAGCATGAGCCAACATGTGGTGGAT
ACAACAAAATTGACCCCTAGACAATTGCGTAAAACCATTTTCAGACCAGTTTCTGAAGGGTCTAATCAAGC
CTCTTTCCGTATTGAAGTGATGAGCTTTGGGTTCAAATATGGTCTTCCTTTGGATGCGGATTTGGTTTTTG
ATGTGCGTTTTCTACCCAATCCTTATTATCAGGTAGAGCTTCGTGAAAAACAGGACTAGATGAGGACGTT
TTTAATTATGTGATGTCTCACCCAGAATCAGAGGTGTTTTACAAGCATTGTGTTAAACCTTATTGTCCCTAT
CTTACCGGCTTACCAAAAAGAAGGGAAGTCTGTCTTGACGGTGGCTATTGGCTGCACAGGAGGCCAACACC
GCAGCGTTGCCTTTGCCCATTTGCTTGGCAGAAAGTCTGGCAACAGATTGGTTCGGTTAATGAAAGCCATCGT
GATCAAAATCGTCGTAAGGAAACGGTGAATCGTTCATGA

SEQ ID NO: 108 amino acid sequence comprising GAS 84

MIKKRTVAILAIASSFFLVACQATKSLKSGDAWGVYQKQKSITVGFNTFVPMGYKDESGRCKGFDIDLA
KEVFHQYGLKVNQAINWDMKEAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIIVKKRSDIKTI
SDMKHKVLGAQSASSGYDSLRLTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYYLAK
GQLENYRMIPTTFENEAFSVGLRKEDKTLQAKINRAFRVLYQNGKFQAISEKWFGDDVATANIKS

SEQ ID NO: 109 polynucleotide sequence encoding GAS 84

ATGATTATAAAAAAAGAACCGTAGCAATTTTAGCCATAGCTAGTAGCTTTTCTTGGTAGCTTGTCAAGC
TACTAAAAGTCTTAAATCAGGAGATGCTTGGGGAGTTTACCAAAAGCAAAAAGTATTACAGTTGGTTTTG
ACAATACGTTTGTTCCTATGGGCTATAAGGATGAAAGCGGCAGATGCAAAGGTTTTGATATTGATTTGGCT
AAAGAAGTTTTTCACCAATATGGACTCAAGGTAACTTTCAAGCTATTAATTGGGACATGAAAGAAGCAGA
ACTAAACAATGGTAAAATTGATGTAATCTGGAATGGTTATTCAATAACTAAGGAGCGTCAGGATAAGGTTG
CCTTTACTGATTCTTACATGAGAAATGAACAAATTATTGTTGTCAAAAAAGATCTGATATTAAACAATA
TCAGATATGAAACATAAAGTGTTAGGAGCACAATCAGCTTCATCAGGTTATGACTCCTTGTTAAGAACTCC
TAAACTGCTGAAAGATTTTATTAAAAATAAAGACGCTAATCAATATGAAACCTTTACACAAGCTTTTATTG
ATTTAAATCAGATCGTATCGATGGAATATTGATTGACAAAGTATATGCCAATTACTATTTAGCAAAAGAA
GGGCAATTAGAGAATTATCGGATGATCCCAACGACCTTTGAAATGAAGCATTTCGGTTGGACTTAGAAA
AGAAGACAAAACGTTGCAAGCAAAAATTAATCGTGCTTTCAGGGTGCTTTATCAAAATGGCAAATTTCAAG
CTATTTCTGAGAAATGGTTTGGAGATGATGTTGCCACTGCCAATATTAAATCTTAA

SEQ ID NO: 110 amino acid sequence comprising N-terminal leader sequence of GAS 84

MIKKRTVAILAIASSFFLVA

SEQ ID NO: 111 amino acid sequence comprising a fragment of GAS 84 where the N-terminal leader sequence is removed

CQATKSLKSGDAWGVYQKQKSITVGFNTFVPMGYKDESGRCKGFDIDLAKEVFHQYGLKVNQAINWDMK
EAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIIVKKRSDIKTISDMKHKVLGAQSASSGYDSL
RTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVYANYYLAKGQLENYRMIPTTFENEAFSVG
LRKEDKTLQAKINRAFRVLYQNGKFQAISEKWFGDDVATANIKS

SEQ ID NO: 112 amino acid sequence comprising GAS 384

MKTLAFDTSNKTLSLAILDDETLADMTLNIQKKHSVSLMPAIDFLMTCTDLKPQDLERIVVAKGPGSYTG
LRVAVATAKTLAYSLNIALVGISSLYALAASTCKQYPNTLVVPLIDARRQNAYVGYYRQGKSVMPPQAHASL
EVIIEQLVEEGQLIFVGETAPFAEKIQKKLPQAILLPTLPSAYECGLLGQSLAPENVDAFVPQYLKRVEAE
ENWLKDNEIKDDSHYVKRI

SEQ ID NO: 113 polynucleotide sequence encoding GAS 384

ATGAAGACACTTGCATTTGATACCTCAAATAAAACCTTGTCCTTGCTATACTTGATGATGAGACACTTCT
AGCAGATATGACCCTTAACATTCAGAAAAACATAGTGTTAGCCTTATGCCTGCTATTGATTTTTTGATGA
CTTGTAATGATCTTAAACCTCAAGATTTAGAAAGAATAGTGGTTGCAAAAGGCCCTGGATCTTACACAGGT
TTACGAGTGGCAGTTGCTACTGCAAAAACGTTAGCGTACAGTTTAAATATTGCATTGGTCGGGATTTTCAG
TCTATATGCTTTGGCTGCGTCTACTTGTAACAGTATCCAAATACTTTGGTGGTGCCATTGATTGATGCTA
GAAGGCAAAATGCGTATGTAGGTTATTATCGGCAAGGAAATCAGTGATGCCACAAGCCCATGCTTCACTA
GAAGTTATTATAGAACAATTAGTAGAAGAAGGACAGCTGATTTTTGTTGGGGAGACTGCTCCTTTTGCTGA

SEQUENCE LISTING

GAAAATTCAAAGAACTACCTCAGGCGATACTACTTCCAACCCTTCCTTCTGCTTACGAATGTGGTCTTT
TGGGGCAAAGTTTGGCACCAGAAAATGTAGACGCCTTTGTCCCTCAATATCTCAAGAGAGTGGAAGCTGAA
GAAACTGGCTCAAAGATAATGAGATAAAAGATGATAGTCACTACGTTAAGCGAATCTAA

SEQ ID NO: 114 amino acid sequence comprising GAS 202

MLKRLWLILGPLLIAFVLVVITIFSPTQLDHSIAQEKANAVAITDSSFKNGLIKRQALSDETCRFVPPFG
SSEWSRMDSMHPSVLAERYKRSYRPFLLIGKRGSASLSHYGIQQITNEMQKKKAIFFVSPQWFTAQGINPS
AVQMYLSNTQVIEFLLKARTDKESQFAAKRLLELNPGVSKSNLLKKVSKGKSLSRDLRAILKQHQVALRE
ESLFSFLGKSTNYEKRLPRVKGLPKVFSYKQLNALATKRGQLATTNNRFGIKNTFYRKRIAPKYNLYKNF
QVNYSYLASPEYNDFQLLLSEFAKRKTDVLFVITPVNKAWADYTGQNDKYQAAVRKIKFQLKSQGFHRIA
DFSKDGGESYFMQDTIHLGWNGWLAFDKKVQPFLETKQVPVNYKMPYFYSKIWANRKLQ

SEQ ID NO: 115 polynucleotide sequence encoding GAS 202

ATGCTTAAGAGACTCTGGTTAATTCTAGGTCCTCTTCTTATTGCCTTTGTTTTAGTAGTGATTACTATTTT
TAGTTTTCTTACACAACCTTGATCATTCCATAGCTCAGGAAAAAGCAAATGCCGTTGCGATCACAGATAGTT
CTTTTAAAAATGGTTTGATTAAAAGACAAGCTTTATCAGATGAGACTTGTCGTTTTGTGCCTTTTTTTGGT
TCTAGCGAATGGAGTCGAATGGATAGTATGCACCCTTCGGTGCTTGCAAGCGCTACAAGCGGAGCTATAG
ACCATTTTTAATTGGTAAGAGAGGATCAGCATCTTTGTGCGATTATTATGGTATACAACAAATTACCAATG
AAATGCAAAAGAAAAAGCCATCTTTGTAGTATCTCCTCAATGGTTTACTGCTCAAGGGATTAATCCTAGT
GCGGTTTCAAGATGTACTTGTCTAACACTCAAGTGATTGAATTTTTACTAAAAGCTAGAACTGATAAGAATC
ACAGTTTGCAGCAAAGCGTTTGCTTGAGCTTAACCCTGGTGTGTCTAAATCAAACCTTATTGAAAAAGTAA
GTAAGGGTAAGTCTCTTAGTCGGTTAGACAGAGCTATTTTGAAATGTCAACATCAAGTAGCATTGAGAGAA
GAGTCCCTTTTTAGTTTTTTAGGCAAATCTACTAACTATGAAAAAGAAATTTTGCCCTCGCGTTAAGGGATT
ACCTAAAGTATTTTCGTATAACAATTGAATGCATTAGCAACTAAGAGAGGCCAATTAGCAACAACCAACA
ACCGTTTTGGGATTAAAAATACATTTTATCGTAAACGAATAGCACCTAAATACAATCTTTATAAGAATTC
CAAGTTAATTATAGTTACCTGGCGTCACCAGAATAACAATGATTTTCAGCTTTTATTATCAGAATTTGCTAA
ACGAAAAACAGATGTACTCTTTGTTATAACTCCTGTTAATAAAGCTTGGGCGGATTATACCGGCTTAAATC
AAGATAAGTATCAAGCGGCAGTTCGTAAAAATAAATTCCAGTTAAAGTCACAAGGATTTTCATCGCATTGCT
GACTTCTCAAAGATGGTGGTGAGTCTTATGCAAGATACCATCCATCTCGGTTGGAATGGCTGGTT
AGCTTTTGATAAGAAAGTGCAACCATTTCTAGAAACGAAGCAGCCAGTGCCCAACTATAAAATGAACCTT
ATTTTTATAGTAAATTTGGGCAAATAGGAAAGACTTGCAATAG

SEQ ID NO: 116 amino acid sequence comprising GAS 057

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVAADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDT
SQITLKTNREKEQSQDLVSEPTTTELADTDAASMAN TGSDATQKSASLPVNTDVHDWVKTKGAWDKGYKG
QGKVVAVIDTGIDPAHQSMRISDVSTAKVSKEDMLARQKAAGINYG SWINDKVVF AHNYVENS DN IKENQ
FEDFDEDWENFEFDAEAEPKAIKKHKIYRPQSTQAPKETVIKTEETDGS HDIDWTQTDDDTKYESHGMHVT
GIVAGNSKEAAATGERFLGIAPEAQVMFMRVFANDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQL
SGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS DHDPLATNP DYGLV GSPSTGRTP TSVAAINSKWVIQRL
MTVKELENRADLNHGKAIYSESVD FKDIKDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
DEMIALAKKHGALGV LIFNNKPGQSNRSMRLTANGMGIPSAFISHEFGKAMSQ L N G N T G S L E F D S V V S K A
PSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQP
NLPKEKIADI VKNLLMSNAQIHVN PETKTTTSPRQQGAGLLNIDGAVTSGLYVTGKDNYGSISLGNITDTM
TFDVTVHNL SNKDKTLRYDTELLTDHVD P Q K R F T L T S H S L K T Y Q G G E V T V P A N G K V T V R V T M D V S Q F T K E
LTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDES GPKDDI
YVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGV
FLRKYQGLKASVYHASDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTTLLGTAFSGKSLTGAELPDGHYHY
VVSYYPDVVGAKRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT
VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFYIMVEDFAGNVAIAKLGDHLPQTLGKTPIKLN
LTDGNYQTKETLKDNL EMTQSDTGLVTNQAQLAVVHRNQ PQSQLTKMNQDFFISP NEDGNKDFVAFKGLKN
NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVM PGDYQYVV TYRDEHGKEHQKQ
YTI SVNDKKPMITQGRFD TINGVDHFTPDKTKALDSSGIVREEVFYLA KKNRKF DVTEGKDGITVSDNKV
YIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTY
LVRDADGKPIENLEYNNNSGNSLILPYGKYTVELLTYDTNAAKLES DKIVSFTLSADNNFQQVTFKITMLA
TSQITAHFDHLLPEGSRVSLKTAQDQLIPLEQSLYVPKAYGKTVQEGTYEVVVS L PKGYRIEGNTKVNTLP

SEQUENCE LISTING

NEVHELSLRLVKVGDASDSTGDHKVMSKNNSQALTASATPTKSTTSATAKALPSTGEKMGLKLRIVGLVLL
GLTCVFSRKKSTKD

SEQ ID NO: 117 polynucleotide sequence encoding GAS 057

GTGGAGAAAAAGCAACGTTTTTCCCTTAGAAAAATACAAATCAGGAACGTTTTTCGGTCTTAATAGGAAGCGT
TTTCTTGGTGATGACAACAACAGTAGCAGCAGATGAGCTAAGCACAAATGAGCGAACCAACAATCACGAATC
ACGCTCAACAACAAGCGCAACATCTCACCAATACAGAGTTGAGCTCAGCTGAATCAAAATCTCAAGACACA
TCACAAATCACTCTCAAGACAAATCGTGAAAAAGAGCAATCACAAGATCTAGTCTCTGAGCCAACCACAAC
TGAGCTAGCTGACACAGATGCAGCATCAATGGCTAATACAGGTTCTGATGCGACTCAAAAAAGCGCTTCTT
TACCGCCAGTCAATACAGATGTTTACGATTGGGTAAAAACCAAAGGAGCTTGGGACAAGGGATACAAAGGA
CAAGGCAAGGTTGTGCGAGTTATTGACACAGGGATCGATCCGGCCCATCAAAGCATGCGCATCAGTGATGT
ATCAACTGCTAAAGTAAATCAAAAGAAGACATGCTAGCACGCCAAAAAGCCGCCGGTATTAATTATGGGA
GTTGGATAAATGATAAAGTTGTTTTTGCACATAATTATGTGAAAAATAGCGATAATATCAAAGAAAATCAA
TTCGAGGATTTTGATGAGGACTGGGAAAACTTTGAGTTTGATGCAGAGGCAGAGCCAAAAGCCATCAAAAA
ACACAAGATCTATCGTCCCCAATCAACCCAGGCACCGAAAGAACTGTTATCAAAACAGAAGAAACAGATG
GTTACATGATATTGACTGGACACAAACAGACGATGACACCAAATACGAGTCACACGGTATGCATGTGACA
GGTATTGTAGCCGGTAATAGCAAAGAAGCCGCTGCTACTGGAGAACGCTTTTTTAGGAATTGCACCAGAGGC
CCAAGTCATGTTTCATGCGTGTTTTTGCCAACGACATCATGGGATCAGCTGAATCACTCTTTATCAAAGCTA
TCGAAGATGCCGTGGCTTTAGGAGCAGATGTGATCAACCTGAGTCTTGGAACCGCTAATGGGGCACAGCTT
AGTGGCAGCAAGCCTCTAATGGAAGCAATTGAAAAAGCTAAAAAAGCCGGTGTATCAGTTGTTGTAGCAGC
AGGAAATGAGCGCGTCTATGGATCTGACCATGATGATCCATTGGCGACAAATCCAGACTATGGTTTGGTGC
GTTCTCCCTCAACAGGTCGAACACCAACATCAGTGGCAGCTATAAACAGTAAGTGGGTGATTCAACGTCTA
ATGACGGTCAAAGAATTAGAAAACCGTGCCGATTTAAACCATGGTAAAGCCATCTATTCAGAGTCTGTCTGA
CTTTAAAGACATAAAAGATAGCCTAGGTTATGATAAATCGCATCAATTTGCTTATGTCAAAGAGTCAACTG
ATGCGGGTTATAACGCACAAGACGTTAAAGGTAAAATTGCTTTAATTGAACGTGATCCCAATAAAACCTAT
GACGAAATGATTGCTTTGGCTAAGAAACATGGAGCTCTGGGAGTACTTATTTTTAATAACAAGCCTGGTCA
ATCAAACCGCTCAATGCGTCTAACAGCTAATGGGATGGGGATACCATCTGCTTTTCATATCGCACGAATTTG
GTAAGGCCATGTCCCAATTAAATGGCAATGGTACAGGAAGTTTAGAGTTTGACAGTGTGGTCTCAAAGCA
CCGAGTCAAAAAGGCAATGAAATGAATCATTTTTCAAATTGGGGCCTAACTTCTGATGGCTATTTAAAC
TGACATTACTGCACCAGGTGGCGATATCTATTCTACCTATAACGATAACCACTATGGTAGCCAAACAGGAA
CAAGTATGGCCTCTCCTCAGATTGCTGGCGCCAGCCTTTTGGTCAAACAATACCTAGAAAAGACTCAGCCA
AACTTGCCAAAAGAAAAAATGCTGATATCGTTAAGAACCATTGATGAGCAATGCTCAAATTCATGTTAA
TCCAGAGACAAAACGACCACCTCACCGCGTCAGCAAGGGGCAGGATTACTTAATATTGACGGAGCTGTCA
CTAGCGGCCTTTATGTGACAGGAAAAGACAACTATGGCAGTATATCATTAGGCAACATCACAGATACGATG
ACGTTTGATGTGACTGTTTACAACCTAAGCAATAAAGACAAAACATTACGTTATGACACAGAATTGCTAAC
AGATCATGTAGACCCACAAAAGGGCCGCTTCACTTTGACTTCTCACTCCTTAAAAACGTACCAAGGAGGAG
AAGTTACAGTCCCAGCCAATGGAAAAGTGACTGTAAGGGTTACCATGGATGTCTCACAGTTCACAAAAGAG
CTAACAAAACAGATGCCAAATGGTTACTATCTAGAAGGTTTGTGTCGCTTTAGAGATAGTCAAGATGACCA
ACTAAATAGAGTAAACATTCCTTTTGTGTTGGTTTTAAAGGGCAATTTGAAAACCTTAGCAGTTGCAGAAGAGT
CCATTTACAGATTAAATCTCAAGGCAAAACTGGTTTTTACTTTGATGAATCAGGTCCAAAAGACGATATC
TATGTCGGTAAACACTTTACAGGACTTGTCACTCTTGGTTCAGAGACCAATGTGTCAACCAAAACGATTTT
TGACAATGGTCTACACACACTTGGCACCTTTAAAAATGCAGATGGCAAATTTATCTTAGAAAAAAATGCC
AAGGAAACCCTGTCTTAGCCATTTCTCCAAATGGTGACAACAACCAAGATTTTGCAGCCTTCAAAGGTGTT
TTCTTGAGAAAATATCAAGGCTTAAAAGCAAGTGCTTACCATGCTAGTGACAAGGAACACAAAAATCCACT
GTGGGTGAGCCAGAAAGCTTTAAAGGAGATAAAAACCTTTAATAGTGACATTAGATTTGCAAAATCAACGA
CCCTGTTAGGCACAGCATTTTCTGGAAAATCGTTAACAGGAGCTGAATTACCAGATGGGCATTATCATTAT
GTGGTGTCTTATTACCCAGATGTGGTGGTGCCAAACGTCAAGAAATGACATTTGACATGATTTTAGACCG
ACAAAAACCGGTACTATCACAAGCAACATTTGATCCTGAAACAAACCGATTCAAACCAGAACCCCTAAAG
ACCGTGGAATTAGCTGGTGTTCGCAAGACAGTGTCTTTTATCTAGAAAGAAAAGACAACAAGCCTTATACA
GTTACGATAAACGATAGCTACAAATATGTCTCAGTAGAAGACAATAAAACATTTGTGGAGCGACAAGCTGA
TGGCAGCTTTATCTTGCCGCTTGATAAAGCAAAATTAGGGGATTTCTATTACATGGTTCGAGGATTTTGCAG
GGAACGTGGCCATCGCTAAGTTAGGAGATCACTTACCACAAACATTAGGTAAACACCAATTAACTTAAG
CTTACAGACGGTAATTATCAGACCAAGAAACGCTTAAAGATAATCTTGAAATGACACAGTCTGACACAGG
TCTAGTCACAAATCAAGCCCAGCTAGCAGTGGTGCACCGCAATCAGCCGCAAGCCAGCTAACAAAGATGA
ATCAGGATTTCTTTATCTCACCAACGAAGATGGGAATAAAGACTTTGTGGCCTTTAAAGGCTTGAAAAAT
AACGTGTATAATGACTTAACGGTTAACGTATACGCTAAAGATGACCACCAAAAACAAACCCCTATCTGGTC

SEQUENCE LISTING

TAGTCAAGCAGGCGCTAGTGTATCCGCTATTGAAAGTACAGCCTGGTATGGCATAACAGCCCGAGGAAGCA
 AGGTGATGCCAGGTGATTATCAGTATGTTGTGACCTATCGTGACGAACATGGTAAAGAACATCAAAAGCAG
 TACACCATATCTGTGAATGACAAAAACCAATGATCACTCAGGGACGTTTTGATACCATTAAATGGCGTTGA
 CCACTTTACTCCTGACAAGACAAAAGCCCTTGACTCATCAGGCATTGTCCGCGAAGAAGTCTTTTACTTGG
 CCAAGAAAAATGGCCGTAAATTTGATGTGACAGAAGGTAAAGATGGTATCACAGTTAGTGACAATAAGGTG
 TATATCCCTAAAAATCCAGATGGTTCTTACACCATTTCAAAAAGAGATGGTGTACACTGTGAGATTATTA
 CTACCTTGTCGAAGATAGAGCTGGTAATGTGTCTTTTGCTACCTTGCGTGACCTAAAAGCGGTGCGAAAAG
 ACAAAGCAGTAGTCAATTTTGGATTAGACTTACCGGTCCCTGAAGACAAACAAATAGTGAAC TTACCTAC
 CTTGTGCGGGGATGCAGATGGTAAACCGATTGAAAACCTAGAGTATTATAATAACTCAGGTAACAGTCTTAT
 CTTGCCCATACGGCAAATACACGGTCTGAATTTGTTGACCTATGACACCAATGCAGCCAAACTAGAGTCAGATA
 AAATCGTTTTCTTTACCTTGTCAGCTGATAACAAC TTCCAACAAGTTACCTTTAAGATAACGATGTTAGCA
 ACTTCTCAAATAACTGCCCACTTTGATCATCTTTTGCCAGAAGGCAGTCGCGTTAGCCTTAAAACAGCTCA
 AGATCAGCTAATCCCGCTTGAACAGTCCTTGTATGTGCCTAAAGCTTATGGCAAACCGTTCAAGAAGGCA
 CTTACGAAGTTGTTGTCAGCCTGCCTAAAGGCTACCGTATCGAAGGCAACACAAAGGTGAATACCTACCA
 AATGAAGTGCACGAAC TATCATTACGCCTTGTCAAAGTAGGAGATGCCTCAGATTCAACTGGTGATCATAA
 GGTATGTCAAAAAATAATTCACAGGCTTTGACAGCCTCTGCCACACCAACCAAGTCAACGACCTCAGCAA
 CAGCAAAAGCCCTACCATCAACGGGTGAAAAAATGGGTCTCAAGTTGCGCATAGTAGGTCTTGTTACTC
 GGACTTACTTGCGTCTTTAGCCGAAAAAATCAACCAAAGATTGA

SEQ ID NO: 118 amino acid sequence comprising N-terminal leader sequence of GAS 57
 MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVA

SEQ ID NO: 119 amino acid sequence comprising a fragment of GAS 57 where the N-terminal leader sequence is removed

ADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDWVKTGAWDKGYKGQKVVAVIDTGIDPAHQSMRISDVSTAKVKSKE
 DMLARQKAAGINYGSWINDKVVFHNYVENS DNIKENQFEDFDEDWENFEFDAEAEPKAIKKHKIYRPQST
 QAPKETVIKTEETDGS HDIDWTQDDDTKYESHGMHVTGIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA
 NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQLSGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS D
 HDDPLATNP DYGLV GSPSTGRTP TSVAAINS KWVIQRLMTVKEL ENRADLNHGKAIYSESVDFKDIKDSL G
 YDKSHQFAYVKEST DAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLI FNNKPGQSNRSMRLTA
 NGMGIPSAFISHEFGKAMSQ L NNGTGSLEFDSVVS KAPSQKGNEMNHFSNWGLTSDGYLKPDITAPGGDI
 YSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPETKTTTSP
 RQQGAGLLNIDGAVTSGLYVTGKDNYGSI SLGNITDTMTFDVTVHNL SNKDKTLRYDTELLTDHVD P QKGR
 FTLTSHSLKTYQGGEVTV PANGKVTVRV TMDVSQFTKELTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQKGTGFYFDES GPKDDIYVGKHFTGLVTLGSETNVSTKTISDNGLHTLGT
 FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHASDKEHKNP LWVSPESFKG
 DKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHYVVSYPDVVGAKRQEMTFDMILDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYTVTINDSYKYVSVEDNKTFVERQADGSFILPLDK
 AKLGDFYVMVEDFAGNVAIAKLGDHLPQTLGKTP I KLKLT DGNYQTKETLKD NLEMTQSDTGLVTNQAQLA
 VVHRNQ PQSQLTKMNQDFFISP NEDGNKDFVAFKGLKNNVYNDLTVNVYAKDDHQKQTPIWSSQAGASVSA
 IESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKYTISVNDKKPMITQGRFDTINGVDHFTPDKTKA
 LDSSGIVREEVFYLAKKNGRKFDVTEGKDGITVSDNKVYIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTYLVRDADGKPIENLEYNNNSGNSLILPYGKYTVE
 LLTYDTNAAKLESDKIVSFTLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQS
 LYVPKAYGKTVQEGTYEVVVS LPKGYRIE GNTKVNTLPNEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKALPSTGEKMGLKLRI VGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 120 amino acid sequence comprising C-terminal hydrophobic region
 LPSTGEKMGLKLRI VGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 121 amino acid sequence comprising a fragment of GAS 57 where the C-terminal hydrophobic region is removed

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDT
 SQITLKTNREKEQSQDLVSEPTTTELADTDAAS MANTGSDATQKSASLPPVNTDVHDWVKTGAWDKGYKG
 QGKVVAVIDTGIDPAHQSMRISDVSTAKVKSKE DMLARQKAAGINYGSWINDKVVFHNYVENS DNIKENQ

SEQUENCE LISTING

FEDFDEDWENFEFDAEAEPAKAIKKHKIYRPQSTQAPKETVIKTEETDGSHDIDWTQTD DDTKYESHGMHVT
 GIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA NDIMGSAESLFIKAI EDAVALGADV INLSLGTANGAQL
 SGSKPLMEAIEKAKKAGVSVVVAAGNERVYGSDDHDDPLATNP DYGLVGS PSTGRTP TSVAAINSKWVIQRL
 MTVKELENRADLNHGKAIYSESVDFKDIKDSLGYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTY
 DEMIALAKKHGALGVLI FNNKPGQSNRSMRLTANGMGIPSAFISHEFGKAMSQ L NNGTGSLEFDSVVS KA
 PSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGA SLLVKQYLEKTQP
 NLPKEKIADIVKNLLMSNAQIHVN PETKTTTSPRQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTM
 TFDVTVHNL SNKDKTLRYDTELLTDHVDPQKGRFTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSQFTKE
 LTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDESGPKDDI
 YVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGV
 FLRKYQGLKASVYHASDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTTLLGTAFSGKSLTGAE LPDGHYHY
 VVSYPDVVGAKRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT
 VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFFYMVEDFAGNVAIAKLGDHLPQTLGKTPIKLK
 LTDGNYQTKETLKD NLEMTQSDTGLVTNQAQLAVVHRNQPQSQLTKMNQDFFISPNE DGNKDFVAFKGLKN
 NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQ
 YTISVNDKKPMITQGRFDTINGVDHFTPDKTKALDSSGIVREEVFYLA KKNRKFDPVTEGKDGITVSDNKV
 YIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTY
 LVRDADGKPIENLEYNNSGNSLILPYGKYTVELLTYDTNAAKLESDKIVSFTLSADNNFQQVTFKITMLA
 TSQITAHFDHLLPEGSRVSLKTAQDQLIPLEQSLYVPKAYGKTVQEGTYEVVVS LPKG YRIEGNTKVNTLP
 NEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQALTASATPTKSTTSATAKA

SEQ ID NO: 122 amino acid sequence comprising a fragment of GAS 57 where both the N-terminal leader sequence and the C-terminal hydrophobic region are removed

ADELSTMSEPTITNHAQQQAQHLTNTELSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
 MANTGSDATQKSASLPPVNTDVHDWVKTKGAWDKGYKGQGVVAVIDTGIDPAHQSMRI SDVSTAKVKSKE
 DMLARQKAAGINYG SWINDKVVF AHNYVENS DN IKENQFEDFDEDWENFEFDAEAEPAKAIKKHKIYRPQST
 QAPKETVIKTEETDGSHDIDWTQTD DDTKYESHGMHVTGIVAGNSKEAAATGERFLGIAPEAQVMFMRVFA
 NDIMGSAESLFIKAI EDAVALGADV INLSLGTANGAQLSGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS
 HDDPLATNP DYGLVGS PSTGRTP TSVAAINSKWVIQRLMTVKELENRADLNHGKAIYSESVDFKDIKDSL
 GYDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLI FNNKPGQSNRSMRLTA
 NGMGIPSAFISHEFGKAMSQ L NNGTGSLEFDSVVS KAPSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDI
 YSTYNDNHYGSQTGTSMAS PQIAGAS L LVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVN PETKTTTSP
 RQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNITDTMTFDVTVHNL SNKDKTLRYDTELLTDHVDPQKGR
 FTLTSHSLKTYQGGEVTV PANGKVTVRVTMDVSQFTKELTKQMPNGYYLEGFVRFRDSQDDQLNRVNI PFV
 GFKGQFENLAVAEESIYRLKSQGKTGFYFDESGPKDDIYVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT
 FKNADGKFILEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHASDKEHKNPLWVSPESFKG
 DKNFNSDIRFAKSTTLLGTAFSGKSLTGAE LPDGHYHYVVSYPDVVGAKRQEMTFDMI LDRQKPVLSQAT
 FDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT VTINDSYKYVSVEDNKTFVERQADGSFILPLDK
 AKLGDFFYMVEDFAGNVAIAKLGDHLPQTLGKTPIKLK LTDGNYQTKETLKD NLEMTQSDTGLVTNQAQLA
 VVHRNQPQSQLTKMNQDFFISPNE DGNKDFVAFKGLKN NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSA
 IESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQYTISVNDKKPMITQGRFDTINGVDHFTPDKTKA
 LDSSGIVREEVFYLA KKNRKFDPVTEGKDGITVSDNKVYIPKNPDGSYTI SKRDGVTLS DYYYLVEDRAGN
 VSFATLRDLKAVGKDKAVVNFGLDLPVPEDKQIVNFTYLVRDADGKPIENLEYNNSGNSLILPYGKYTVE
 LLTYDTNAAKLESDKIVSFTLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLIPLEQS
 LYVPKAYGKTVQEGTYEVVVS LPKG YRIEGNTKVNTLPNEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQA
 LTASATPTKSTTSATAKA

SEQ ID NO: 123 amino acid sequence of a GAS M protein

MAKNNTNRHYSRLKLTGTASVAVALTVLGAGFANQTEVKANGDGNPREVIEDLAANNPAIQNIRLRYENK
 DLKARLENAMEVAGRDFKRAEELEKAKQALE DQRKDLETKLKE LQDYDLAKESTSWDRQRLEKELEEKKE
 ALELAIDQASRDYHRATALEKELEEKKALELAIDQASQDYNRANVLEKELETITREQEI NRNLLGNAKLE
 LDQLSSEKEQLTIEKAKLEEEKQISDASRQSLRRDLASREAKKQVEKDLANLTAELDKVKEDKQISDASR
 QGLRRDLASREAKKQVEKDLANLTAELDKVKEEKQISDASRQGLRRDLASREAKKQVEKALEEANSKLA
 ALEKLNKELEESKKLTEKEKAELQAKLEAEAKALKEQLAKQAEELAKLRAGKASDSQTPDTKPGNKAVPGK
 GQAPQAGTKPNQNKAPMKETKRQLPSTGETANPFFTAAL TVMATAGVA AVVKRKEEN

SEQUENCE LISTING

SEQ ID NO: 124 amino acid sequence of GAS SfbI

MSFDGFFLHHLTNELKENLLYGRIQKVNQPPERELVLTIRNHRKNYKLLLSAHPVFGRVQITQADFQNPQV
 PNTFTMIMRKYLQGAVIDEQLEQIDNDRIIEIKVSNKNEIGDAIQATLIIEIMGKHSNIILVDRAENKIIES
 IKHVGFSQNSYRTILPGSTYIEPPKTAAVNPFTITDVPLFEILOQELTVKSLQQHFQGLGRDTAKELAE
 LTTDKLKRFRFFARPTQANLTTASFAPVLFSDSHATFETLSMDLDFYQDKAERDRINQQASDLIHRVQT
 ELDKNRNKLKSKQEAELLATENAELEFRQKGELELTYLSLVPNNQDSVILDNYTGEKIEIALDKALTPNQNA
 QRYFKKYQKLKEAVKHLGLIADTKQSITYFESVDYNLSQASIDDIEDIREELYQAGFLKSRQDKRHKRK
 KPEQYLASDGTITILMVGRNNLQNEELTFKMAKKGELWFHAKDIPGSHV I I KDNLDPSDEVKTDAAELAAYY
 SKARLSNLVQVDMIEAKKLHKPSGAKPGFVITYTGQKTLRVTDPQAKILSMKLS

SEQ ID NO: 125 amino acid sequence of a GAS Shp protein

MTKVVIKQLLQVIVVFMISLSTMTNLVYADKGQIYGCIIQRNYRHPISGQIEDSGGEHSFDIGQGMVEGTV
 YSDAMLEVSDAGKIVLTFRMSLADYSGNYQFWIQPGGTGSFQAVDYNITQKGTDTNGTTLDIAISLPTVNS
 IIRGSMFVEPMGREVVFYLSASELIQKYSNMMLAQLVTETDNSQNQEVKDSQKPVDTKLGESQDESHTGAM
 ITQNKPKANSSNNKSLSDKKILPSKMGLTTSLELKKEDKFRSKKDLSIMIYYFPTFFLMLGGFAVWVWKKR
 KKNDKTM

SEQ ID NO: 126 amino acids 10 to 30 of GAS protein SagA

FSIATGSGNSQGGSGSYTPGKC

SEQ ID NO: 127 polynucleotide sequence comprising fusion construct 117-40a-RR

ATGGCCTTTAACACAAGCCAGAGTGTCAAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATGCG
 TAGCGGTGGCGGATCCATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACCCAGAAACAATTCAAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAAATCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACA
 AAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAAATCAAAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAGAGAGGCAGAACTTAGTCGTC
 TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAG
 CAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAAGTGCAAAATGAGCTAGCGCAGTTTGCA
 GCTCACATGATTAATAGTGTAAGTCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAA
 TGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACAT
 ACGGCCATGCTATTAACTTTTACGTGTAGATAAACATAACCTAATGC GCCTGTTTACCTTGGATTTTCA
 ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCCTATAAAAGCCGTGGAAGTACAAAAGATTATGCC CAAAGAGTAGGCACTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
 AAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGAGTGACAGCACTGGTGGCTAAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACAGTTGACTTTGCTTAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA

SEQUENCE LISTING

CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACG
 AAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAATAACAAGTCTTGTAGCAGAAGCGCTTGTTGG
 CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCATAAATCACATCTTCGATTACTCAGCCCTCAT
 CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAA
 cGtgcgggccgcactcgagCACCACCACCACCACCAC

SEQ ID NO: 128 amino acid sequence comprising fusion construct 117-40a-RR

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q F A A H M I N S
 V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
 S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
 D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
 H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
 E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
 T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V
 S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
 A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
 A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
 N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
 T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
 T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
 E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
 K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 129 amino acid sequence comprising a linker in the 117-40a-RR construct
YASGGGS**SEQ ID NO: 130 polynucleotide sequence comprising 40a-RR-117 fusion construct**

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAACTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACTACTAATACTCT
 TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACAAAAAGCTAGCATTTC
 GCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATAAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCTGCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTATCCTCTTGAAGAACTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
 TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAcGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACATGAGTAATAACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAATGGTATTAAACGTGGT

SEQUENCE LISTING

ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
 CTTTTTACGTGTAGATAAACATAACCCTAATGC GCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCC CAAAGAGTAGGCACTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTT GTCGGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
 CCTTAGCAGAGCAAGCCGCAAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGTGCAATATCTAAGG
 GACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTTGATAATACTAAGCAAGATTTGGC
 TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACCTATTAGAAG
 CTTAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCATTGTGTCTAAAATCACA TCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTTC TGATGTTGATGAAAGTACTCAACGCTgctagcgggtggcg
 gatccatggcctTTAACACAAGCCAGAGTGTCA GTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCAT
 TTGACTGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGA
 CGGCTACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCGTTATGGGAC
 TATCAAGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCAT
 TATgcgggccgcactcgagCACCACCACCACCACCAC

SEQ ID NO: 131 amino acid sequence comprising the 40a-RR-117 fusion construct

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
 T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
 A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P
 Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
 A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
 F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
 K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
 A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
 Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
 T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
 K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
 I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
 G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
 Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
 Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
 S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
 D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
 E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
 S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A S G G
 G S M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K
 D N A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L
 S S E Q D I E K H Y E E L K N K L H D M Y N H Y A A A L E H H H H H

SEQ ID NO: 132 polynucleotide sequence comprising fusion construct GAS 117 - 40a

ATGGCCTTTAACACAAGCCAGAGTGTCAAGTGCAC AAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAAATCACACCTGCAATATAGTAAAGAC AACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTA TTATTACTACAACCTAAGAAC GTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACACTATGAAGAGC TTAAGAACAAGTTACATGATATGTACAATCATTATgc

SEQUENCE LISTING

CAGCGGCTGGCGGATCCATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAAAGTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGCTGAAATCAACCACCTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACA
 AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
 TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAGATATTCCAG
 CAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGGCTAGCGCAGTTTGCA
 GCTCACATGATTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAAAGCTCATGGTAATACAAGACCATCATTTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACTGTGAA
 TGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACAT
 ACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCA
 ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
 AAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTTGGCTAAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA
 CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACG
 AAACAACTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTTGG
 CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCAT
 CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAA
 cGtgcgccgcgactcgagCACCAACCACCACCACCAC

SEQ ID NO: 133 amino acid sequence comprising fusion construct GAS 117-40a

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
 A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
 E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
 V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
 V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
 Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
 E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
 E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
 L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
 K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
 K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
 Q Y Q D I P A D R N R F V D P D N L T P E V Q N G L A Q F A A H M I N S
 V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
 S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
 D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
 H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
 E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
 T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V

SEQUENCE LISTING

S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H H

SEQ ID NO: 134 polynucleotide sequence comprising fusion construct GAS 117-40N

ATGGCCTTTAACACAAGCCAGAGTGTCTAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCA
AGTGAGCAAGACATTGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATGC
tagcgggtggcggatccCATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATT
GATGCAGTTGAAAAA ACTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
TACTGCTGAAATCAACCACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGAGCTGCATTGTCAGAACA
AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGTCTGAACAAA
ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAA
AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
TTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
CCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAAATCAATACCAAgcggccgcac
tcgagCACCACCACCACCACCAC

SEQ ID NO: 135

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q A A A L E H H H H H H

SEQ ID NO: 136

AGTTGGTA

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